

COMPARATIVE ADVANTAGES OF CLAMP-ON TRANSIT-TIME ULTRASONIC FLOWMETERS OVER CONVENTIONAL INTRUSIVE FLOWMETERS

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1. Introduction

Recent developments have enabled today's clamp-on transit-time ultrasonic flowmeter technology to reach a level of applicability, functionality, economy and performance which establishes this instrument as the prime candidate to replace most, if not all, the conventional intrusive flowmeters in most of their niche applications. This paper describes the advances that have taken place and how users of conventional intrusive flowmeters may evaluate for themselves the advantages available to them by use of the clamp-on transit-time ultrasonic flowmeter in place of any of their prior intrusive flowmeter types.

2. Why are there so many different types of intrusive flowmeters?

Users of flowmeters are faced with a multiplicity of different intrusive flowmeters which they may choose to fulfill their flowmetering needs. The need for these many different types is due to the fact that each type will function properly only with a liquid whose properties are compatible with its particular sensing principle.

For each liquid they use, they must have the knowledge to determine which type of intrusive flowmeter will function properly. They must also have expertise in maintenance of each type, as well as the expense of spare parts for all of the different types that they use. It would therefore be of great advantage to have a single type of flowmeter which could function well in essentially all applications. The clamp-on transit-time ultrasonic flowmeter of the latest generation, as represented by Controlotron's System 1010 Uniflow, is just such an instrument.

The cost of an intrusive flowmeter, and its installation, is not the end of the cost liability of users of intrusive flowmeters. Consider the cost of the shutdown in plant operation necessitated by an unscheduled failure of an intrusive flowmeter. In addition, most intrusive flowmeters must be periodically removed for cleaning, scheduled maintenance or re-calibration due to wear. While this can sometimes be done during normal process shutdown, it is often necessary to stock a spare unit so that operation can continue while the flowmeter calibration is completed.

Why then are there so many different types of intrusive flowmeters? Clearly, the primary reason for the multiplicity of different types, aside from the question of cost compatibility, is due primarily to the fact that each type of flowmeter exists because it has a special ability to operate with a particular type of liquid which the user may be handling.

For example, turbine flowmeters operate well with clean lubrication liquids, but fail quickly if the liquid is at all abrasive. They also have the disadvantage of a limited "turndown" ratio, so that if the application demands flow measurement over a wide range of flow, it is possible that more than one turbine will be required.

Magnetic flowmeters are usable only for electrically conductive liquids, but suffer from contamination of the electrical contacts which are exposed to the liquid.

Venturi flowmeters have a reputation for high accuracy, but this accuracy deteriorates rapidly if deposits form on their interior surfaces, or when wear occurs.

Vortex shedding flowmeters are not recommended for operation when flow velocities put the application's Reynold's number below 10,000 (i.e. in the turbulent region of flow). Therefore, they are limited not only in turndown ratio, but also in their ability to operate at all at low flow velocities. Naturally, any liquid which abrades or coats the blunt body surfaces will destroy the system calibration.

The old standby, the orifice plate, has a very limited turndown ratio, in combination with high pressure drop and flow response non-linearity. Their low initial cost is often counterbalanced by the high cost of the pumps and the energy needed to overcome their high pressure drop. Their service reliability is often confused with calibration stability, which in fact deteriorates rapidly as the edges of the orifice wear due to the effect of the flowing liquid.

Finally the coriolis principle mass flowmeter is highly repeatable, but is affordable only in small pipe sizes, and has a substantial pressure drop. Liquids which can coat the interior of the meter can cause error or complete malfunction.

In short, the wide diversity and non-descript nature of liquid properties and conditions which can come in contact with any intrusive flow sensing element dictates the need for many types of intrusive flowmeters just to provide one which could even be considered for use. Then among the types which could function with the user's liquid, he must choose a type which can provide the required performance under the conditions of flow which exist.

Generally, the non-descript nature of most liquids is such that the intrusive flowmeter's manufacturer may not even be able to predict, much less guarantee, the level of performance which could be achieved with a user's actual liquid.

3. The Benefits of Clamp-On Transit-Time Ultrasonic Flowmetering

Consider, in comparison, the benefits of the Controlotron System 1010 Uniflow Clamp-On Transit-Time Ultrasonic Flowmeter. Here is a meter that overcomes all previously listed objections since its transducers never come in contact with the liquid, and whose operating principle depends only on the liquid and the pipe having a minimum degree of sonic conductivity, a property of essentially all liquids and pipes.

3.1 Universal Uniflow Applicability

The term Uniflow stands for "Universal Flowmeter", referring to its universal applicability to essentially any type of liquid in essentially any type of pipe. All that is required for System 1010 to operate is a modicum of sonic liquid conductivity, a property of most liquids, and a pipe which is sonically conductive, again, a property of essentially any pipe, metal or plastic. The only liquids which may not be applicable are those which are totally aerated, such as foams, or with a very heavy concentration of mineral solids, such as sand slurries. Even high concentrations of organic solids, such as 50% coal in oil or water, will not prevent Uniflow from operating.

What is unique in Controlotron's Uniflow design is its ability to adjust itself to the actual conditions of the application's pipe and liquid without assistance from the user, who in fact rarely even knows the liquid or pipe parameters in most cases. Uniflow actually measures the liquid and pipe parameters by itself, and sets its own operating controls so as to provide optimum performance. It is this breakthrough that underlies the new ability of the transit-time ultrasonic flowmeter to overcome past limitations of this technology, which has always had the potential for universal applicability, but which, up to now, did not always realize this potential in actual service.

Uniflow is also universal in the sense that one model is programmable to a wide range of different pipe sizes and pipe materials, including lined pipes. Only several models cover pipe sizes from as small as 1/4 inch O.D. to as large as 360 inches. Uniflow accommodates wall thicknesses from 0.01 to 3 inches and will operate on all types of metal and plastic pipes. Pipe linings of plastic, glass, epoxy and cement are routinely accommodated. As noted above, it is not necessary to "tell" Uniflow anything about the liquid, as Uniflow will get this data by itself as it sets itself up for operation. Therefore a user of Controlotron's System 1010 Uniflow need not maintain a stock of many different "body sizes" to cover either the different pipe sizes or liquids which he must accommodate.

3.2 Outstanding Uniflow Performance

But where Uniflow really shines is in performance. No other type of flowmeter has the rangeability of Uniflow, which is guaranteed to operate from at least plus to minus 40 foot per second flow velocity, including zero flow, and with a flow sensitivity of 1/1000 foot per second at any flow velocity in this range.

Its linearity is usually better than 0.1%. It is highly repeatable and has no hysteresis, since its operation does not depend on taking any energy from the flow stream and therefore there are no frictional effects.

Uniflow has the fastest response time of any type of flowmeter. It collects basic flow data approximately 1000 times per second and publishes computer processed flow rate data 10 times per second. This permits a full 110 Hz bandwidth for high speed control applications. The system's hand held terminal can be used to provide further damping should the user not wish to see the actual flow fluctuations which Uniflow's inertia-less sensing can detect.

Uniflow's intrinsic accuracy is essentially equivalent to the best intrusive flowmeters. Furthermore, it holds its accuracy much better, since there is not deterioration of accuracy due to wear, as there is no contact at all between Uniflow's transducers and the liquid, as there is in all intrusive flowmeters. Furthermore, a flow calibrated Uniflow can provide satisfactory custody transfer accuracy in most applications.

3.3 Simple Uniflow Installation and Set Up

Uniflow is extremely simple to install and set up for operation in any application. Transducers install in less than 5 minutes, even on large pipe diameters. All application data, including selection of the desired flow range, units, data outputs and display options are selected by use of a hand held terminal which offers all possible choices on selection lists, avoiding the need for the installer to spell any selection. The only keyed entries that the installer makes are the numerics having to do with pipe dimensions and desired scaling. And in portable models, the user can SAVE Site Setup data for instant RECALL when a site is revisited, if desired.

3.4 Wide Choice of Uniflow Models and Functions

Controlotron's System 1010 Uniflow is available in models suitable for essentially any site environment. Standard NEMA 4X and 7 models with a choice of Digital or Graphics display with visible programmable stripchart and datalogger displays are available. There are also a full range of field programmable battery operated Portable models.

In addition, as a help in replacement of any conventional intrusive flowmeter, Uniflow includes all data outputs that are provided by any and all conventional intrusive flowmeters, as well as some that are not ordinarily available. Uniflow provides both flow rate and total data. It provides 0 to 10 volt and 4 to 20 mA isolated output, pulse rate output, computer compatible serial RS-232 I/O. It provides programmable flow status relay output alarms, such as Empty Pipe, Hi or LO flow, Reverse Flow as well as Aeration or Cavitation alarms.

3.5 How to Evaluate Uniflow Against Conventional Intrusive Flowmeters

Perhaps of greatest benefit to users who are considering replacing their conventional intrusive flowmeters with Uniflow is its ability to be evaluated with great convenience and minimum expense. All that a user needs to do is to install a Portable Uniflow at a location where his conventional intrusive flowmeter is now functioning. It takes only five minutes to do, and of course does not require cutting the pipe at all. Then just compare Uniflow's ease of installation and performance to that of the installed flowmeter and decide if Uniflow can provide equal or better operation.

What will make it all especially attractive is the low installed cost of Uniflow's dedicated NEMA 4 models, which compare favorably to most conventional intrusive flowmeters. As an added benefit, consider the added economy of never having to shut down process operation for installation or maintenance, and of reduced cost for flowmeter maintenance since there is no liquid deterioration of Uniflow's non-intrusive transducers.

Clearly, the advantages of Controlotron Uniflow Clamp-On flowmeters over conventional intrusive flowmeters are easy to establish by actual comparative trial, in the field in real applications, and in the flow laboratory where its published performance specifications can be validated. All users of intrusive flowmeters can easily avail themselves of Portable Uniflow models to enable personal observation of these advantages.

