Universal and safe:

Level detection for liquids employing the vibration measurement principle

The determination of levels in liquids forms part of standard measurement technology in all industries ranging from the chemical industry to the sanitary areas of the pharmaceuticals and food industry. The ideal level detection instrument can be employed in all applications and offers – despite its versatility – maximum dependability and safety in any specific application. In the course of recent years, the vibration principle of Liquiphant sensors has come out on top in all industries world-wide because of its simplicity, the high degree of dependability, the universal application range and the absence of maintenance work.

The vibration principle

Endress+Hauser had the measurement principle of detecting levels by a vibrating fork already patented in 1966. After the first product, a level detection instrument for solids, had been developed and successfully introduced a level detection instrument for liquids followed very soon: the Liquiphant. Liquiphant belongs to the limit switches which are functionally based on the effect of the frequency change of the fundamental mode of the tuning fork in dependency on the moved mass. Moved mass in respect of the sensors of the Liquiphant type is the liquid medium in which the tines of the tuning fork are oscillating. The alteration of the resonant frequency of the tuning fork as compared with the frequency of free oscillation in the air depends on the contact area of the tuning fork with the medium as well as on the density and viscosity of the medium. The vibration frequency of the sensor depends to a lesser degree on the process temperature and the process pressure. A liquid with a density of > 0,5 g/cm^3 at a temperature between –40 and +150°C and a pressure of up to 40 bar may thus be detected unproblematically.
The vibornic sensor works with a piezo drive which, on the one hand, stimulates self-resonant vibrations in the tuning fork and compensates the loss in energy of these vibrations. On the other hand, it controls the frequency of the tines and supplies the feedback for fundamental wave analysis. The sensor operates either with a stack or bimorph drive.

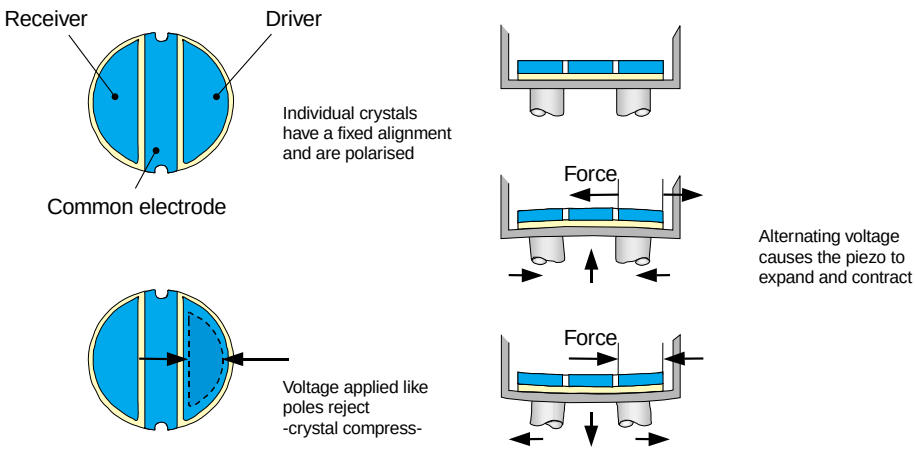
Quality as a feature of construction

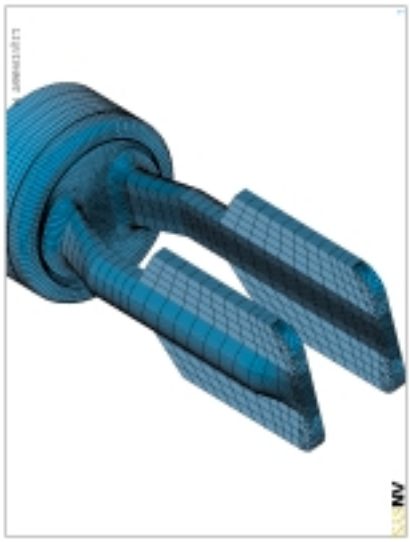
Very high demands were made on the development, construction and production of the sensor and the fork. An optimum solution had to be found for the interaction of material selection, mass production and the pertaining costs. Therefore, the fork was designed as an investment casting part and constructed for this process from the beginning which meant little fluctuation in wall thickness and no exothermic edges. The second important point concerned the material. It was imperative that the level limit switch be used, if possible, in all liquids and also under extreme conditions. The investigation for suitable materials was conducted together with the responsible foundry. Depending on the aggressiveness of the medium to be measured either the already relatively corrosion-resistant material G-X5 CrNiMoNB 18 10 (Material No. 1.4581/"stainless steel") is being used or the highly corrosion-resistant alloy NiMo 16 Cr 16 Ti (Material No. 2.4610 / "Hastelloy C") which is particularly resistant against intercrystalline corrosion, stress cracking and pitting corrosion. Stainless steel alloy is mainly used in case of an acid exposure of medium intensity. Therefore, this casting material is to be found frequently in the food, film, photographic, colour as well as nitre industry.

The highly corrosion-resistant casting material, Haselloy C, is even under reducing and oxydating conditions extremely resistant, i.e. it is also resistant against hot, polluted media like sulphuric or nitric acid, solvents, chlorine and chloric media. Therefore, it is frequently employed in environmental technology. Both materials command relatively high mechanical properties, the materials lend themselves very well to welding. The fork electronically monitors the possible occurrence of corrosion during operation which is done with the assistance of a resonant window. Surpassing a limit value of the resonant frequency indicates corrosion.

In order to facilitate verification, testing and optimisation of application safety even during the development phase, Endress+Hauser invested in an independent department for the simulation of complex processes in sensor and application technology already more than 10 years ago. This department uses computer-aided methods, e.g. the finite element method, in order to simulate material stability and product behaviour. The finite element method modelled the mechanical structures of the fork of the Liquiphant with small elements and determined deformation, extension, tension and oscillation under stress conditions via elasticity-specific interdependencies.

Liquiphant M - Bimorph Piezo System

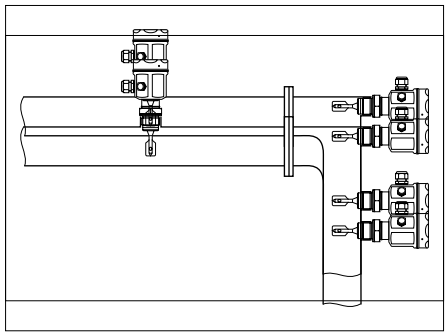




Apart from the determination of these theoretical interdependencies application-oriented solutions in piezo technology are being investigated under laboratory conditions in the so-called Application Technology Department.

Innovations in the new Liquiphant M

The new Liquiphant generation, the Liquiphant M, is based on the application experience of decades in vibration measurement and offers a number of innovations.
The minimised tines with a length of only 40 mm may be installed in pipes with a diameter of DN 25 or larger.
The new Liquiphant M sensor is equipped with a bimorph drive and designed for process connections of ¾ inch or larger. Parallel and conical threads, screwed parts, DIN flanges of DN 25/1" or larger, hygienic and aseptic connections like milk pipe or triclamp couplings as well as extension tubes are available for process connections. Special high temperature versions up to +280 °C and coated versions (PFA/ECTFE enameled) will follow. Industry-specific housings for the chemical, pharmaceuticals and food industry with the respective selection of process connections and certificates ensure optimum adaptation to different application tasks. A range of electronic inserts offers, e.g., connections to switching units and transmitters, programmable logical controllers, process control systems and fieldbus systems.



NAMUR

The new Liquiphant M meets the EN 50227 NAMUR standard.
In the area of limit switches, NAMUR signifies instruments having only a firmly defined, very small power consumption. This means that the voltage and current values of the sensors and transmitters are very low. The standard concerns proximity sensors connected to an isolating amplifier by a two-core cable. The isolating amplifier contains a DC power source which feeds the control circuit and is controlled by the variable internal resistance of the proximity sensor. These instruments may be used in hazardous locations if they also meet EN 50020 "Intrinsically safe electrical apparatus for hazardous locations i".
Having two types of ignition protection, i.e. EEx ia and EEx d, Liquiphant M offers the highest degree of safety for hazardous locations.

Stringent requirements, a clean solution: Application in foodstuffs

Hygienic areas place the most stringent requirements on a level measurement instrument. Large temperature fluctuations, cleaning, sanitary and disinfection procedures wear on the sensor and measuring device. Demands which the new Liquiphant M complies with in an optimum fashion having a polished sensor, the respective hygienic connections which are easily cleaned, extension tubes and a housing of stainless steel with IP 66/67 ingress protection according to EN 60529. The housing has an etched nameplate and is ideally suited for applications in food facilities with frequent high-pressure cleaning from outside. Liquiphant M holds both the EHEDG and 3A Expertise approval which are important for such applications.

Universal and economical

The application in almost all areas of industry has confirmed that the vibration limit switch described here, Liquiphant M, is an all-purpose instrument suited for level monitoring in all liquids.
There are divers ways of installation: Top mounting for monitoring maximum level; bottom mounting for monitoring minimum level; side mounting for monitoring minimum and maximum level or pipe mounting for the protection of pumps from running dry.

The range of application of the vibration limit switch, Liquiphant M:

- Limit detection in all liquids which may still be pumped
- Process tanks, emulsion tanks, pipes (where the size of the fork is of importance), storage tanks
- Liquids with a proportion of solids, aggressive media
- Medium with a density from 0,5 g/cm³ onwards
- Liquid temperatures of -40°C to +150°C
- Pressure range 0...40 bar
- Viscosity up to 10.000 mm²/s
- The function is not impaired by currents, turbulences, vibration, solid content, sticky media, sparkling or foaming media, build-up or abrasion by aggressive media.

For the user, this means that only one type of instrument is required to cover the most varied measurement tasks of an operation. Storage and spare part stocks are considerably simplified. The maintenance instructions of mechanical instruments, e.g. of float switches, demand regular cleaning and careful inspections at certain intervals. If a company has had several of such instruments installed this might be a considerable cost factor.

At this point, the electronically functioning vibration limit switch, Liquiphant, offers an interesting alternative. More than one million instruments employed world-wide in all industries confirm that it works practically free of maintenance. Vibration systems like the one described with their wide range of applications have thus definite advantages if a level limit switch is supposed to be employed in many different ways, independent of the properties of the media like viscosity, the degree of pollution, temperature and electric characteristics.

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