"THE TINY SENSOR" FOR SPECIAL TASKS

PRECISE FILLING LEVEL MONITORING THROUGH THE SMALLEST OF OPENINGS

In automated filling or dosing processes, a reliable check of filling levels is usually necessary. The medium to be monitored and the container itself often pose the user with challenges. These can, however, be overcome with special solutions.

A chemical company fills products in small glass bottles at an automatic dosing station. For this purpose, the bottles with openings the size of a test tube are transported to a dosing unit by a transport unit and filled there with a precise quantity of a clear, transparent liquid. The quantity of product filled in each bottle must be absolutely identical. Therefore, each container should be inspected for the proper filling level prior to sealing.

SEEMS OBVIOUS, BUT NOT A SOLUTION

For this task, the company first tested a light barrier (transmitter/receiver system) with linear light beam that operates based on the proportion of coverage. This was intended to detect the filling level on the side of the glass wall of the bottles. The transparent liquid in the bottles did not, however, enable sufficient damping and, as a result, did not provide a clear signal. Light refraction further encumbered a reliable filling level check.

FILLING LEVEL CHECK INDEPENDENT OF MEDIA PROPERTIES

Due to the various challenges, the chemical company next opted for an ultrasonic sensor. The advantage of such devices: With ultrasound, it is possible to detect, among other things, filling levels in containers almost completely irrespective of the specific media properties. To monitor the filling level, it is necessary to position the sensor above the bottle opening which, in this case, has a diameter of just 10mm.

But this solution did not yield the desired result. The reason: An ultrasonic transmitter cyclically emits a short, high-frequency acoustic pulse. If this is incident on an object, the pulse is reflected by the object's surface as an echo in the direction of the diffuse reflection sensor. The sound transducer integrated in the device simultaneously performs the function of the transmitter and receiver. After the acoustic pulse is generated, the sound transducer thus functions as a receiver for only a short period of time. Because the propagation velocity of sound in air is known, the distance from an object surface to the sensor can be determined using the time-of-flight measurement of the pulse from the time it was sent to the time it is received. Here, it is always the first echo signal that is evaluated, i.e. the signal of the reflection surface closest to the sensor, independent of whether any other reflection signals from more distant surfaces are received.

Decisive in the context of the described practical example are the surface of the sound transducer and the angle of beam spread of the emitted sound cone. Because standard ultrasonic sensors have sound transducers with a relatively large surface area depending on the size of the sensor, the large angle of beam spread of the resulting sound cone from the used sensor meant that the sound cone also included the edge of the small bottle openings. As a result, the echo signal produced by the edge of the bottle was the first received signal and was used for distance determination. The result: The ultrasonic sensor only detected the distance from the sensor to the edge of the bottle.

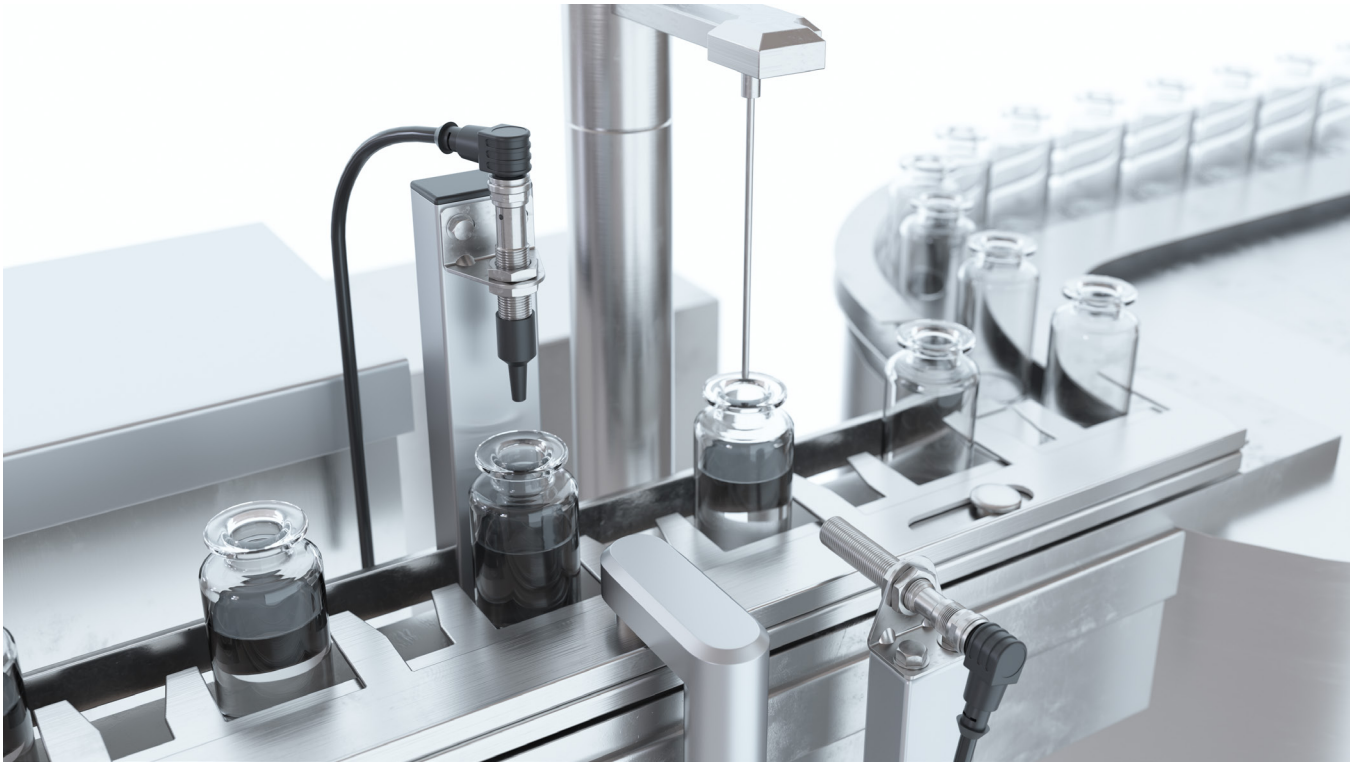
PRECISE CONTROL THROUGH SMALL OPENINGS

Even though the attempts using the standard device failed, the choice of technology was nevertheless correct. Ultimately, an ultrasonic sensor of the **UT12** series was used. This has a diameter of just 12mm. The series offers solutions with switching output for position sensing (**UT129520**) and versions with analog output for measurements that are proportional to distance (e.g. with filling level checks) such as the **UT129021**.

ONE SERIES FOR MANY TASKS

In the filling system of the chemical company, the **UT129021** was mounted directly behind the dosing unit to enable the filling level to be detected. What makes this device special is the so-called beam columnator attached to the sensor head. The beam columnator focuses the ultrasound, producing an almost linear sound cone. This further reduces the exit angle and the angle of beam spread of the sound compared to a device without beam columnator. In this way, it is possible to check the filling levels in containers with very small openings. The resulting analog signal from the sensor, which is proportional to the filling level, is evaluated by the primary control unit. The advantage: The reference value and the permissible tolerances for the filling level can be used flexibly in the control unit, allowing various batches with different filling levels to be produced. Bottles with a filling level that is too high or too low are ejected from production by the system control.

Moreover, a **UT129520** with digital switching output for presence checking is installed at the dosing unit itself to ensure that a bottle is actually located at the desired position prior to the filling process.



Ultrasonic sensors of the **UT12** series in an automated dosing system: The device behind the dosing unit monitors the filling levels from above through the small bottle openings. Another sensor with switching output is used to perform the presence check. (All images: ipf electronic)

The ultrasonic sensors of the **UT12** series have a diameter of just 12mm. Above is the **UT129520** with digital switching output. Below is the **UT129021**, which is used by a chemical company for filling level monitoring.

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