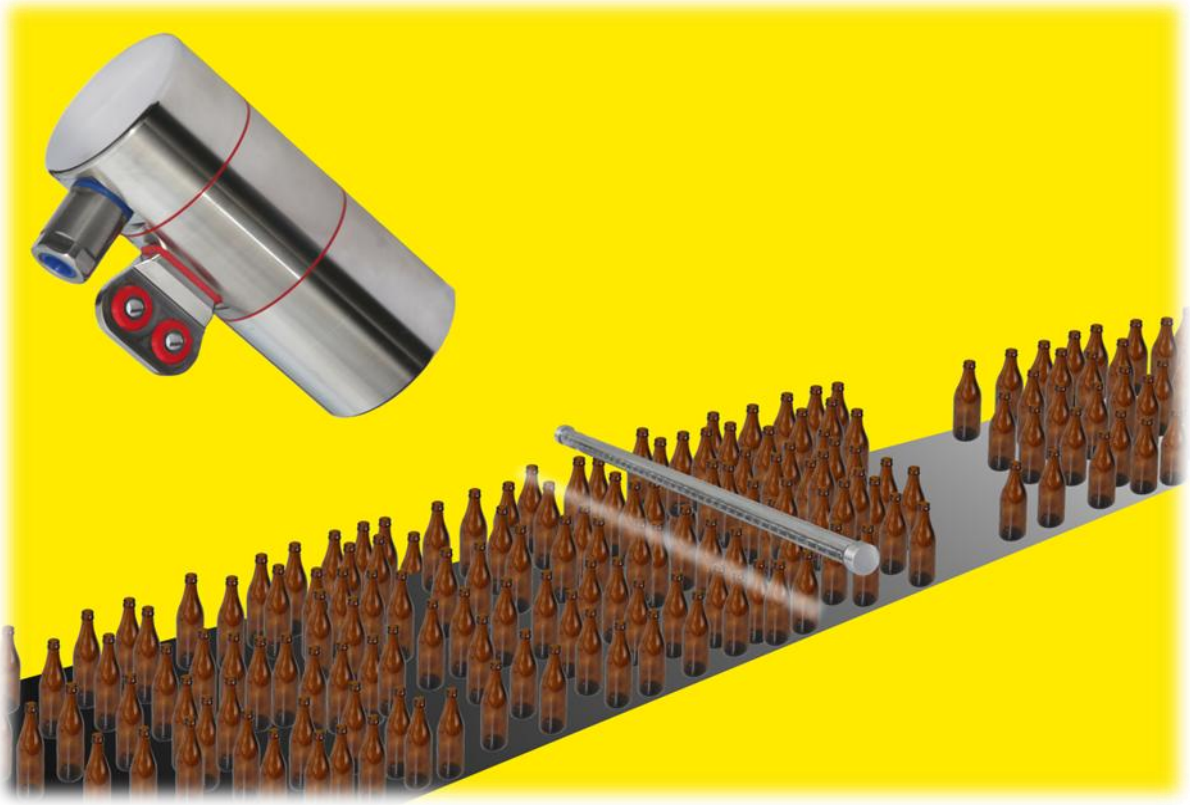
Non-Contact Container Counting

during Bulk Conveying

DKAM-28HD **counting system**

DKAM certified according to EHEDG from 2012/Q3



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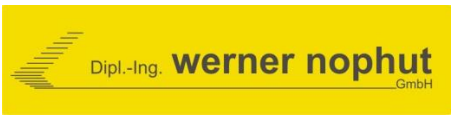
1 General

Resulting from the research project

- Sensor System for Bulk Container Counting -

a counting system is now available for use in the food industry, too.

The following partners were involved in the research project:



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This counting system has primarily been developed for glass bottles, but can be extended to other containers as well.

By controlling the buffer lines dependent on the current result provided by this counting system, the plant owners profit in various ways by

1. **Increase in the efficiency of the entire filling system**
2. **Noise reduction**
3. **Energy savings**
4. **Reduction of back pressure**

See chapter 10 for more detailed information.

The DKAM-28HD counting system was tested both under controlled conditions on the FPT test specimen and on industrial filling systems rendering very good results.

The following explanations exclusively refer to the use in filling systems, in which glass bottles are conveyed in mass transport containers in any arrangement and are counted during this process.

Demonstration of the functionality on the model of TUM, FPT in Weihenstephan:

The containers (here: glass bottles) are conveyed in circles on a disk and are counted. The system distinguishes between open and closed bottles.

2 Certification in accordance with EHEDG

The DKAM will be certified in accordance with EHEDG in the third quarter of 2012.

3 Performance characteristics of the DKAM-28HD counting system

The DKAM-28HD counting system is used to count containers during bulk conveying without touching them, and to transfer the results in XML format via Ethernet to the control system at short intervals.

- The counting system recognizes and counts glass bottles which are arranged in any order on a conveyor line.
- The velocity may range between > 0 and 500 mm/s. Velocity changes during the counting process in this area will not result in errors.
- In the case of a holdup, bottles may be inside the counting area. The bottles move on the running conveyor and may be shifted sideways due to the emerging back pressure.
  This will not cause any errors, as the bottles are recognized and are tracked on their way through the sensor area until they will have left it.
- The DKAM-28HD counting system is designed for a conveyor width of 1000 mm. Other widths may be implemented as well.
- The system distinguishes between open and closed bottles.
- In addition to the counting results, the bottle positions may be transferred as well.
- Other user-specific tasks can be added.

4 Where can the DKAM-28HD counting system be used?

Wherever bottles are to be conveyed and counted in bulk.
This may be in new systems, but also in a retrofit of an existing system, during:

- buffer input
- buffer output
- new glass input
- etc.

Note:

A non-reflecting bottle opening may result in that bottle not being recognized and thus not being counted.

5 DKAM-28HD counting system

The counting system comprises only three components:

- DKAM (data processing camera) from Dipl.-Ing. Werner Nophut GmbH
  for recognizing and counting the containers. No PC required!
- Line lighting with activation
- Distributor housing

5.1 DKAM:

- Stand-alone counting facility: Image recording and counting inside the DKAM, without PC
- Communication: Ethernet TCP/IP XML-based
  USB 2.0 visualization for setup
- Housing: Stainless steel, electropolished
- Gaskets: PUR
- Degree of protection: IP65
- Disk: Glass, 3mm
- Mounting: According to the instructions: Gaskets and cap nuts with flange are included
- Dimensions: d = 86mm, l = 192mm
  plus mounting accessories and cable glands
- Electrical connection: Cable glands
- Cable connection: 5m, pre-assembled in PUR sleeving

5.2 Line lighting:

- LED lighting in plastic tube with lateral connection and mount made of stainless steel.
- Dimensions: d = 45mm, approx. l = 1300mm for 1000mm bandwidth
- Cable connection: 3m PUR cable with cable gland

5.3 Distributor housing:

- Stainless steel housing
- Degree of protection IP65 or higher

Pre-assembled with cable glands for:

- 24 Volt incoming supply
- Ethernet to switch (control)

- Connector for DKAM inside PUR tube:
  - Power supply
  - Ethernet
  - USB local, ending in distributor housing!

- Lighting

6 Electrical connections on system side

- 24 Volt supply (=), 3A for a 1000mm wide conveyor
- Ethernet (TCP/IP)

7 System requirements

Naturally the systems must meet certain conditions so that the DKAM-28HD system is able to influence the conveyor system.

Major requirements:

- It must be possible to steplessly control the transport system's velocity or at least in several increments.
  Max. velocity of a 1m wide conveyor: 500 mm/s
- The control system should support Ethernet
- The control system must have resources available so that the required algorithms can be processed in real time.

8 Installations on system side

If the system meets the requirements, the following installation activities will be required:

8.1 Mechanical installation

Owing to the counting system's small footprint it is easy to integrate it in new or already existing filling systems.

The DKAM and line lighting must be mounted to a stable stainless steel frame adjusted to the system. The distributor housing is mounted under the conveyor.

The arrangement may look as follows:

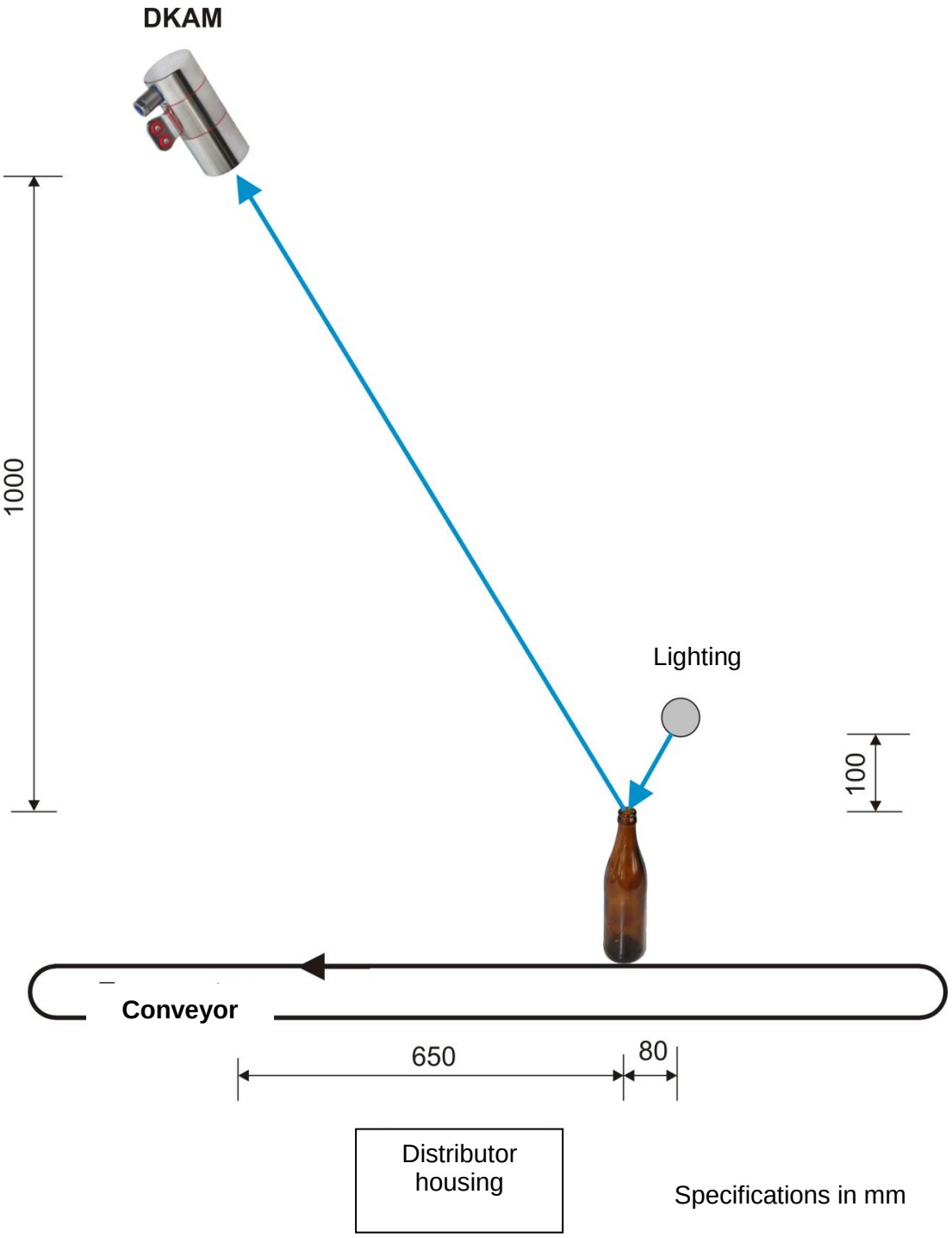

Fig.: Arrangement of DKAM and lighting. The distributor housing's placement must be adjusted to the system.

The following photo shows the effect of the lighting.
The two bottles on the left with the light edge are completely illuminated.
The arrows (>>>) point this out.
The bottles on the right are only partly illuminated.

> > >

Fig.: The photo shows the differences in bottle illumination

In general, the lighting is mounted a few centimeters above the bottles across the transport direction. The light spreads laterally approximately 150mm around the outer position of the bottle center.
The DKAM is positioned about 1000mm above the bottle opening and in the center of the conveyor.
This height was defined for a conveyor width of up to 1000mm.

Remarks:

- The DKAM and lighting must be fixed in line with the Hygienic Design [6] directives.
- In addition the mounting instructions for the DKAM-28HD must be followed.
- Bright illumination or direct sunlight on the bottles must be avoided in the counting area.

8.2 Electrical installation

The distributor housing is required using the connections described above.

On the system side you will only have to provide

- a 24V supply and
- an Ethernet connection

and connect them accordingly.

The DKAM provides a 5m long PUR tube containing the following cables:

- 24V DKAM supply
- Ethernet
- USB (local)

Insert the tube containing the cables in the provided cable gland and connect the cables.

The USB cable ends in the distributor housing. It is required for adjusting the DKAM and lighting.

The lighting provides a 3m long PUR cable which must be inserted in the cable gland and connected accordingly.

Note:

The cables for the DKAM and lighting must be laid in a way that they are visible and can be replaced easily for servicing.

9 Integration of the counting results on system side

Any additional information about the number of bottles that have been conveyed into the buffer as well as the number of bottles that have left the buffer within the same period of time will show how many bottles are currently inside the buffer.

In combination with a previously defined buffer filling level, the control system can regulate the transport line in a way that the required number of bottles is inside the buffer during undisturbed operation.

The bulk end may be calculated using the time when the bottles pass the counting facility as well as additional parameters such as the known line velocity.
This enables a smooth and low-noise closing of the gaps.

The corresponding algorithms were developed by Dipl.-Ing. Sorgatz [1] for his dissertation at TUM.

10 Advantages for the system owner

In this approach we want to optimally control a buffer distance according to the defined buffer filling level.
In the buffer input and/or buffer output the bottles are conveyed in bulk.

The DKAM-28HD counting system provides the essential results.

The number of bottles conveyed in bulk is recorded, which helps to create a temporal relation when they will pass the counting facility.

Based on state-of-the-art technology these findings alone point to the advantages for the system owner.

Four major areas are affected:

1. **Increase in the efficiency of the entire filling system**
2. **Noise reduction**
3. **Energy savings**
4. **Reduction of back pressure**

A buffer distance between two aggregates that is optimally regulated by the buffer filling level will cause a continuous workload and will thus increase efficiency [1].
Correct counting results [2] provided by the DKAM-28HD are the prerequisite for optimal control.

The legal regulations for occupational safety of beverage filling systems with regard to noise have been tightened in the course of the last few years and must be met [1], [3], [4].
Smooth closing of the gaps within the bottle flow contributes to noise reduction.
The position of the bulk end on the conveyor can be calculated using the data provided by the DKAM-28HD counting system. The velocity of the conveyor must be reduced shortly before new bottles arrive.

Energy savings during conveying can be achieved by adjusting the velocity of single conveyor segments (up to individually driven flat top chains) to the current need [1].
At the same time this will reduce the noise, too.
This is based on the data from the DKAM-28HD counting system.

Furthermore, an adjusted velocity will cause an enormous reduction of the back pressure on the glass bottles. This will reduce creation of scuffing traces, so that the bottle pool can be used for several additional rotations [1], [5].
A lower back pressure will also facilitate conveying of fitted individual bottles that tend to get wedged.
Thus, the DKAM-28HD counting system also contributes to the conservation of resources and safe conveying.

However, here we only want to point out the technical possibilities. Any investment made for implementation and any considerations regarding ROI, etc. are greatly dependent on the filling system and must therefore be made individually.

11 Abbreviations

DKAM	**D**atenverarbeitende **KAM**era = data-processing camera (smart camera)
EHEDG	European Hygienic Engineering & Design Group
Ethernet	Network protocol for local networks
Hygienic Design	Cleanable constructive design of machines
Bulk	Here: Large number of bottles in any order
ROI	Return On Investment
Scuffing	Whitish traces of wear on deposit bottles when they are dry
TCP/IP	Transmission Control Protocol / Internet Protocol
XML format	Extensible Markup Language. Language for exchanging structured data

12 Bibliography

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Stepless control of material flow systems using the example of container conveyors in beverage filling systems
Reviewed by: Prof. Dr. Langowski

[2] Dissertation 2004
Dr. Tobias Voigt
New methods for the use of information technology in beverage filling systems
Reviewed by: Prof. Dr. Weisser

[3] Directive 2003/10/EC of the European Parliament and of the Council of 6 February 2003 on the minimum health and safety requirements regarding the exposure of workers to the risks arising from physical agents (noise), European Parliament and Council, (March. 2007)

[4] German Federal Law Gazette Part 1; No. 8, decree for implementing EC directive 2002/44/EC and 2003/10/EC for the protection of workers against the dangers caused by noise and vibration, (March 2007)

[5] Dissertation 2001
Dr. Sabine Jirokovsky
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[6] Dr.-Ing. Jürgen Hofmann
Hygienic Design Ingenieurbüro Hofmann, Zorneding

Also see: www.LVT.wzw.TUM.de/index.php?id=28

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