Metal Detectable Brush Bristles

Do They Work?

Debra Smith, Iobal Hygiene Specialist, Vikan A/S, Denmark

Introduction: Foreign body contamination of foods can be a safety or quality issue, or both. Regardless, if a food is contaminated by a foreign body, the repercussions for the food business can be expensive and damaging. Consequently, the food industry constantly seeks ways to minimise the risk of foreign bodies in food, including the use of metal detection.

One source of foreign body contamination is food industry cleaning brushware, where the bristles can snap, be cut, or detach from the brush head and enter the food product. Brushes with metal detectable bristle are available to the food industry and have been marketed as a way of detecting foreign bodies from this source, but do they work?

Debra Smith
Global Hygiene Specialist

Vikan
ADVANCING HYGIENIC CLEANING

Purpose

To investigate the durability, functionality, detectability and cleanability of metal detectable brush bristles.

Methods

Durability - tests to assess the break strength and elongation of metal detectable and plastic bristles were performed by Zwick Roell, using a Zwicki 5kN *(Figure 1)*.

Functionality - the ability of metal detectable bristled brushware to clean a surface of a wet (tinned chopped tomatoes) and a dry (mix of milk powder and coffee granules) food soil, was compared with that of a standard plastic bristled brush, using a robotic cleaning rig *(Figure 2)*.

Metal detectability - in collaboration with Mettler Toledo, metal detectable bristles were investigated with regard to their detectability using a Profile Advantage multi-frequency Metal Detector, with and without the presence of packed fresh chicken and packed granulated sugar *(Figure 3)*.

Cleanability - Metal detectable and plastic bristles were contaminated *(Figure 4a)* with Brownes test soil (Isopharm Ltd.) and cleaned under the same conditions *(Figure 4b)*.

Load Cell: 200N HP
Extensometer: Crosshead
Grips: Pneumatic Grips - 8190 Newtons
Jaws Insert: Oxidceramics
Clamping Pressure: 4 bar

Pre-Load: 1 Newton
Speed, Pre-load: 10 mm/min
Test Speed: 20 mm/min
Grip to Grip distance at start: 100 mm

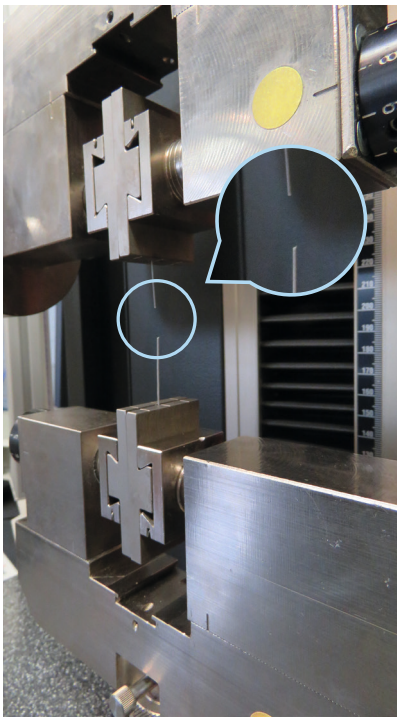


Figure 1. Zwicki 5kN bristle strength and elongation assessment equipment (Zwick Roell, Germany).

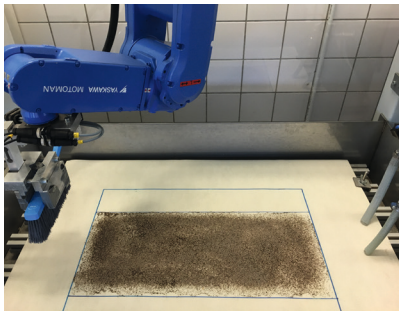


Figure 2. Robotic cleaning rig (Vikan, Denmark).

Transport Speed: 18 m/m
Aperture Size: 350 x 175 mm

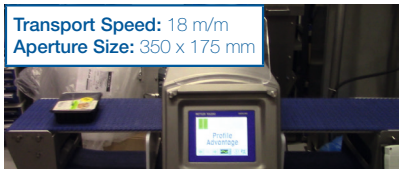


Figure 3. Profile Advantage multi-frequency Metal Detector (Mettler Toledo, Denmark).

Figure 4a. Brush contamination usig Brownes test soil.

Figure 4b. Cleaning of the soiled brush.

Results

Durability - Plastic (polyester) bristles were 68% stronger and more than twice as elastic as metal detectable bristles *(Tables 1a & 1b and Graphs 1a & 1b)*.

Functionality - based on visual assessment, metal detectable bristled brushes were no more effective at cleaning than standard plastic bristled brushes *(Figures 5a & 5b)*.

Metal detectability - metal detectable bristles were not detectable in the presence of food *(Table 2)*.

Cleanability - Visual inspection by microscope (Nikan SM21500) showed that metal detecable bristles were rougher and harder to clean *(Figures 6a & 6b)*.

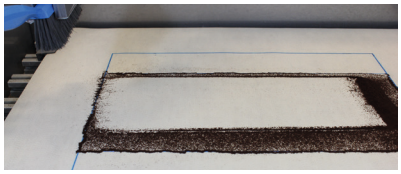


Figure 5a. Cleaning with a metal detectable bristled brush.

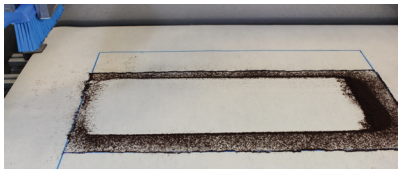


Figure 5b. Cleaning with a plastic bristled brush.

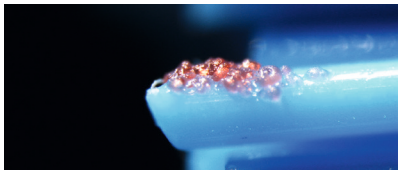


Figure 6a. Plastic bristles after cleaning (160x magnification).

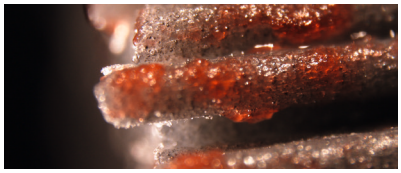


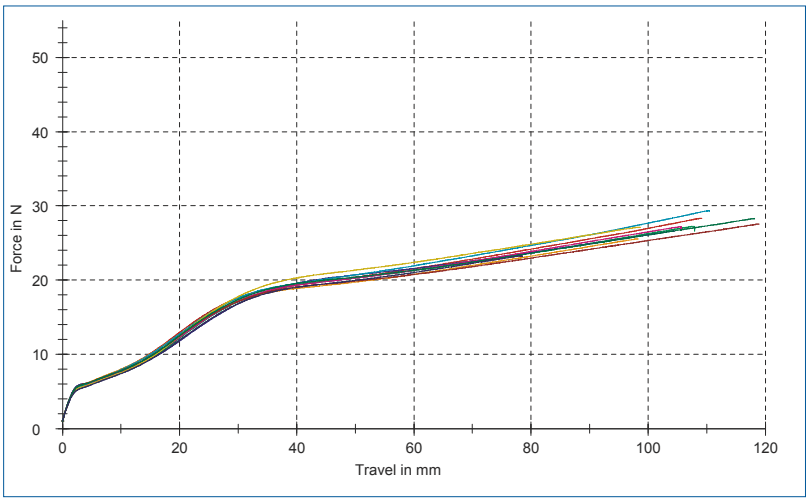
Figure 6b. Metal detectable bristles after cleaning (160x magnification).

Results

Durability data:

Table 1a. 0.35 mm plastic bristle break strength & elongation.

Plastic n = 10	F_{max} [N]	dL at F_{max} [mm]
x̄	27.0	104.9
s	1.69	11.7
v} [%]	6.26	11.11



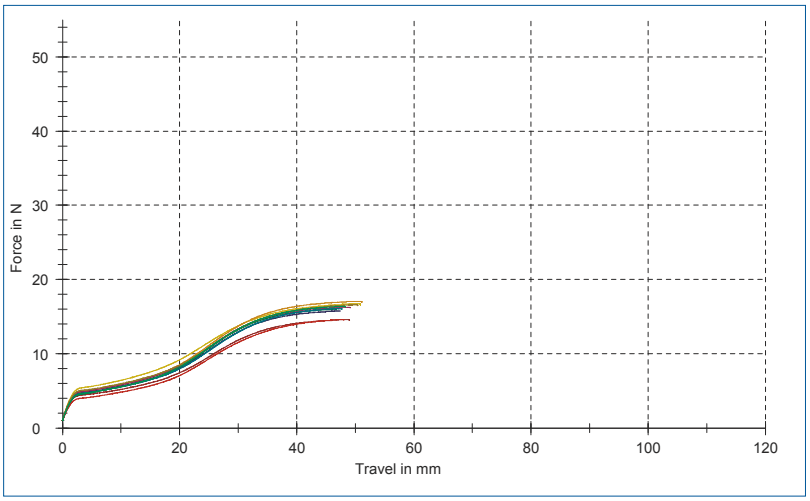
Graph 1a. 0.35 mm plastic bristle break strength & elongation.

F_{max}:
Bristle Strength

dL at F_{max}:
Bristle Elongation (Elasticity)

Table 1b. 0.35 mm metal detectable bristle break strength & elongation.

Metal detectable n = 10	F_{max} [N]	dL at F_{max} [mm]
x̄	16.0	48.3
s	0.826	1.3
v} [%]	5.16	2.74



Graph 1b. 0.35 mm metal detectable bristle break strength & elongation.

Detectability data:

Table 2. Metal detectable bristle detection with and without the presence of food.

Bristle Diameter [mm]	Bristle Length [mm]	Bristle orientation		No food	Sugar (dry)	Chicken breast (wet)
0.35	100	|	—	*1.8	N/D	N/D
0.50	100	|	—	*2.2	N/D	N/D
0.60	100	|	—	*2.5	N/D	N/D
0.35	50	|	—	N/D	N/D	N/D
0.50	50	|	—	*1.8	N/D	N/D
0.60	50	|	—	*2.3	N/D	N/D

N/D = Not Detected.
**Minimum threshold for detection (equivalent to a ferrous sphere of the same diameter).*

References: EHEDG Guideline Document No.8 (2018). Hygienic equipment design criteria.
EHEDG Guideline Document No.32 (2005). Materials of construction for equipment in contact with food.
Lock, A., 1990. The Guide To Reducing Metal Contamination In The Food Processing Industry. Safeline Metal Detection Ltd.
Acknowledgements: Vikan would like to thank Mettler Toledo and Zwick Roell for their collaboration during this study.

Significance Based on the findings of this study

1) Metal detectable bristled brushware offers no advantage with regard to cleaning efficacy and are unlikely to minimise the risk of bristle contamination of food. In fact, they may increase it due to their reduced strength and elasticity, and a perception that any metal detectable bristles will be controlled via the metal detector.
Currently, only relatively thick metal detectable bristles are available, i.e., there are no brushes with bristle thicknesses of <0.35 mm. However, fine bristled brushes are more effective at removing fine powders, including some allergens. Consequently, the use of thicker bristled brushes may result in poor cleaning efficacy and therefore, increase the risk to the business/consumer.

2) The detectability of metal detectable bristles will depend on a number of factors *(Figure 7)*. The influence of these factors is variable and accumulative and they will affect the detection threshold. Consequently the ability of a metal detector to detect very small metallic objects is limited.

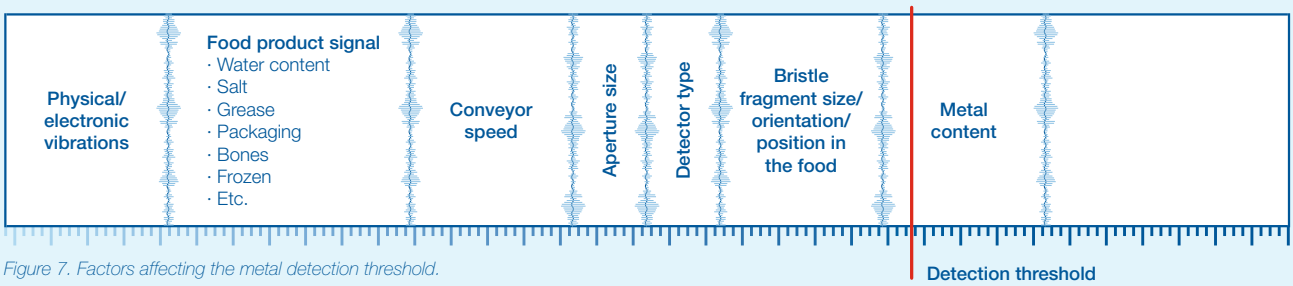


Figure 7. Factors affecting the metal detection threshold.

Additionally, the data shown in *Table 3* (Lock, 1990), indicates that, to achieve a similar detection to that of a standard ferrous test piece with a spherical diameter of 1.5 mm, metal wire lengths of between 3 mm and 8 mm would be required.

Table 3. Lengths of metal wire required to obtain a similar level of metal detection to that of a 1.5 mm spherical diameter ferrous sphere. (Lock, 1990).

Ferrous ball (spherical diameter)	Pure steel paper clip (ferrous) 0.95 mm cross-sectional diameter	Pure copper wire (non-ferrous) 0.91 mm cross-sectional diameter	Pure stainless steel wire EN 58/AISI 304L (part-ferrous) 1.16 mm cross-sectional diameter
1.5 mm	3 mm long	9 mm long	8 mm long

Currently brushes with metal detectable bristles are only available with bristle diameters of 0.35 mm, 0.5 mm and 0.6 mm, i.e., much thinner than the metal wires assessed in Table 3. It can be concluded therefore that even longer lengths of metal detectable plastic bristles would be required to achieve the same level of detection. Given this, it is unlikely that metal detectable plastic bristles/bristle fragments would be detectable in a food product, especially given detector and product variances, and that bristle fragments are likely to be small.

3) The roughness of the metal detectable bristles made them harder to clean. Residúal soil on brush bristles will increase the risk of cross contamination. Consequently, the material used to make them should be easy to clean, in line with bygienic design guidelines (EHEDG, 2018 & 2005).

Conclusion: Metal detectable bristled brushes may in fact increase the risk of product contamination, due to their reduced cleanability, strength and elasticity, combined with a perception that they will be detected by the metal detector.