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EVALUATION OF EFFICIENCY OF REMOVING PROTEIN DEPOSITS FROM VARIOUS SURFACES BY FOAM CLEANING

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ABSTRAKT

The paper presents results of the research on efficiency of removing the protein deposits by using foam cleaning technique. Eight surfaces used in the food industry (tiles, linoleum, antibacterial and traditional tiles and stainless steel) constituted the research object. Surfaces were contaminated by protein derived from milk and egg proteins and they were cleaned by foam technique at variable parameters of compressed air pressure and the contact time of the detergent with the tested surface. The results of the research confirmed that the compressed air pressure of cleaning solutions has the highest impact on the protein deposits removal..

Introducion

Maintaining a high level of hygiene in a food processsing plant is a big challenge. Development of appropriate procedures and instructions regarding hygiene is the essence of the business and builds customer confidence in the context of the quality of the produced food. Hygiene is very important for the proper cleaning and disinfection processes in which physical, chemical and microbiological impurities accumulated on the surfaces of production, which are a major threat to the production process are removed (Koziróg, 2012). These processes can be conducted in many ways depending, inter alia, on the type of surface being cleaned and its availability (Diakun, 2013). For example, pipelines are washed in CIP systems, small appliances manually or by immersing, and large surfaces with foam cleaning or high-pressure jet. The use of new solutions concerning finishing of surfaces considerably facilitates maintaining cleanness. In addition to traditional materials the finishing ones are increasingly being used in the form of anti-bacterial surfaces of ceramic tiles and epoxy resins (Rai et al., 2009).

They allow maintaining a high level of hygiene between subsequent cleaning and disinfection procedures (Mierzejewska and Stawczyk, 2013). Foam washing is used for cleaning large surfaces such as floors, walls, smoking chambers, worktops and external parts of machines and equipment.

This method, due to a number of advantages, has found wide application in industry, inter alia, fish, meat and milk production. The results are part of a series of studies concerning: removing various types of contaminants (fat, protein and sugar without any treatment and after heat treatment); various foam cleaning process parameters (pressure, temperature, time); impact of different detergents and cleaning susceptibility to a variety of surfaces in the food industry (Mierzejewska and Stawczyk, 2013).

Objective of the study

The objective of the study was to evaluate the effectiveness of removing protein impurities from various surfaces in the food industry. Such surfaces were examined, as tiles, stainless steel, linoleum, ceramic and anti-bacterial tiles. Compressed air pressure and the detergent contact time with the surface constituted variable parameters during the process.

Test stand

The study was conducted on the foam cleaning bench with a foam generator with equipment (fig. 1), a booth for surface mounting and washing operation and tiles made of various materials (fig. 2).

Figure 1. Foam cleaning stand: 1 – pump, 2 – retractable reel, 3 – stationary terminal, 4 – lance with appropriate nozzle, 5 – compressor 6 – cleaner

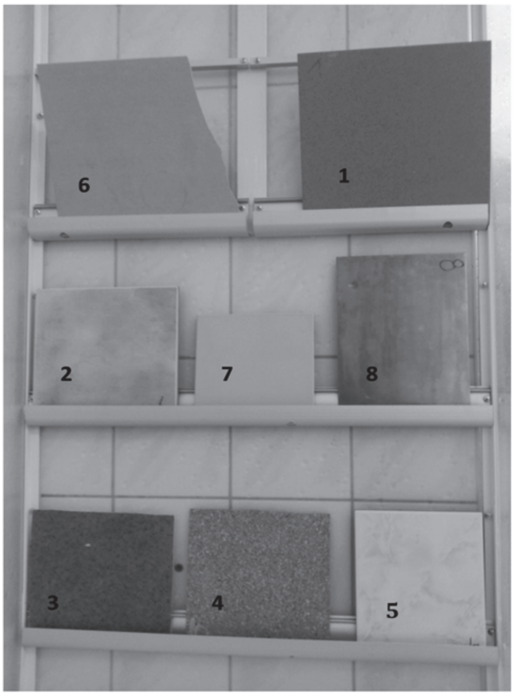

Figure 2. Surfaces subject to contamination and cleaning: stone tiles (1, 2), linoleum (3, 4), ceramic tiles (5), anti-bacterial tile (6), attested anti-bacterial tile (7), stainless steel (8)

A foam generator consisted of a base station equipped with: a pump (1) increasing the water pressure to 2.5 MPa and a compressor (5) delivering compressed air to the stationary terminal (3). Water, compressed air and the cleaning agent dosed in appropriate amounts, are applied as a foam on the cleaned surfaces with a lance equipped with a nozzle (4) adjusted to the process. In order to facilitate access to the cleaned surface the lance is mounted on a 25 m hose on a drum with a motor (2).

Surfaces subjected to the process of contamination and washing were placed in a specially adapted cabin, enabling the attachment of the washed items and preventing foam splashing.

Research methodology

The soiling and cleaning process was performed on 8 different surfaces: two types of tiles with different roughness, two types of linoleum, ceramic plate, the antibacterial plate, antimicrobial-approved plate and stainless steel. The tests were performed in triplicate. The study used two types of protein impurities, namely, impurities arising from pasteurized milk and 2% of chicken egg protein.

Impurities after being applied to the surfaces were fixed in a thermal chamber at 80ºC. The washing process was carried out in the foam technology by maintaining constant dispensing of chlorine detergent, at different pressure of compressed air (0.6, 0.8; 1.0 MPa) and for different contact times of foam with the cleaned surface (5; 10; 20 min).

Evaluation method of cleaning effectiveness

Cleaning efficacy was assessed in two ways: visualy according to standard BS EN 50242-2004 and with the use of rapid tests to detect protein residues Clean-Trace ™ Surface Protein Plus Protect (Diakun, 2011; BS EN 50242-2004). The scale of evaluation of those two methods and awarded points are presented in table 1.

Table 1
Numerical scale of the cleanliness surface evaluation

Visual assessment	Clean-Trace™		Scoring
dirt area PN-EN 50242-2004	Protein residue of	color reagent	
Lack	0-30 $\mu g \cdot \mu l^{-1}$	green liquid	5
Number of small point particles of dirt 1 to 4 and the area completely dirty ≤ 4mm²	30-60 $\mu g \cdot \mu l^{-1}$	liquid green-gray	4
Number of small point particles of dirt spot 5 to 10 and the area completely dirty ≤ 4mm²	60-80 $\mu g \cdot \mu l^{-1}$	liquid gray	3
Number of small point particles of dirt spot >10 area ≤ 4mm² or area completely dirty ≤50mm²	80-120 $\mu g \cdot \mu l^{-1}$	liquid gray-purple	2
50 mm²< Area completely dirty ≤ 200 mm²	120-300 $\mu g \cdot \mu l^{-1}$	purple liquid	1
Area completely dirty >200 mm²	300-500 $\mu g \cdot \mu l^{-1}$	deep purple liquid	0

Results and Discussion

Since equal effectiveness of removing protein impurities from milk and egg white was proved, the group test results for the removal of both types of impurities were presented. Foam produced at the pressure of 0.6 MPa was of poor quality, namely, was very moist and quickly ran down from the cleaned surface. Therefore, no studies have been conducted for the pressure of 0.6 MPa and the times of 10 and 20 minutes. Figure 3 shows the results of the protein removal efficiency for a pressure of 0.6 MPa and a time of 5 min. With the set parameters of the process no satisfactory cleaning performance was achieved. As many as 3 of the investigated areas received 0 pts., remaining ones received 2, 3 points, and they were still heavily contaminated. Increasing the air pressure to 0.8 MPa resulted in significant improvements in the quality and durability of foam and thus the efficient removal of protein impurities. Studies carried out after 10 and 20 minutes of the detergent contact with the surface of the test showed that only one surface (stainless steel) was still contaminated. Other areas have received 5 points, which means that the protein impurities have been completely removed from the test surface (fig. 4).

Increasing the air pressure to 1.0 MPa resulted in an improved removal efficiency even at the shortest contact time (5 min) (fig. 5). Still most contaminants remained on the surface of stainless steel. Extending the active foam cleaning surfaces to 10; 20 minutes resulted in the removal of all contaminants from all the tested surface.

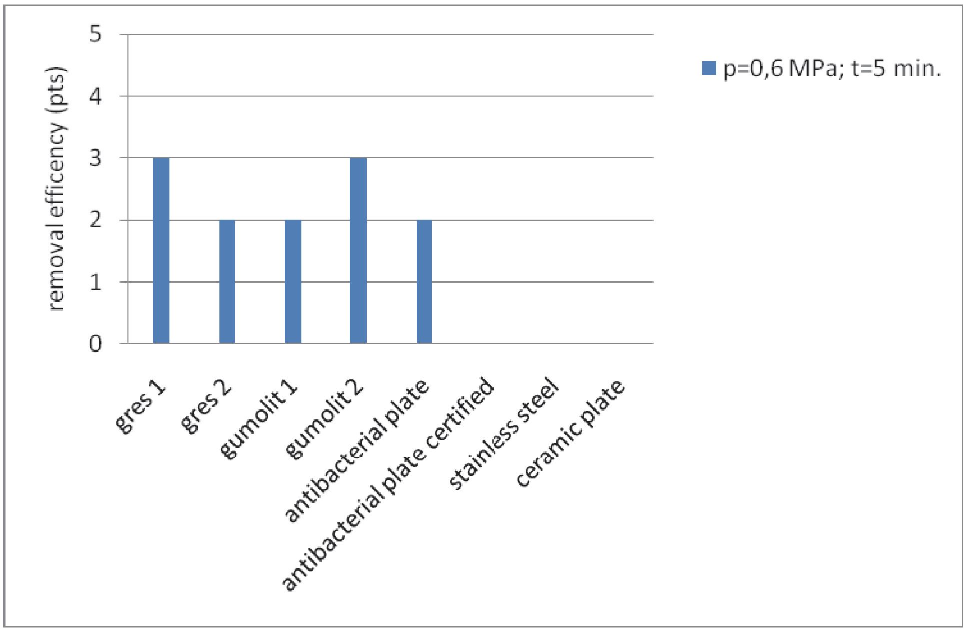

Figure 3. Effectiveness of removing protein impurities (p=0.6 MPa, t=5 min)

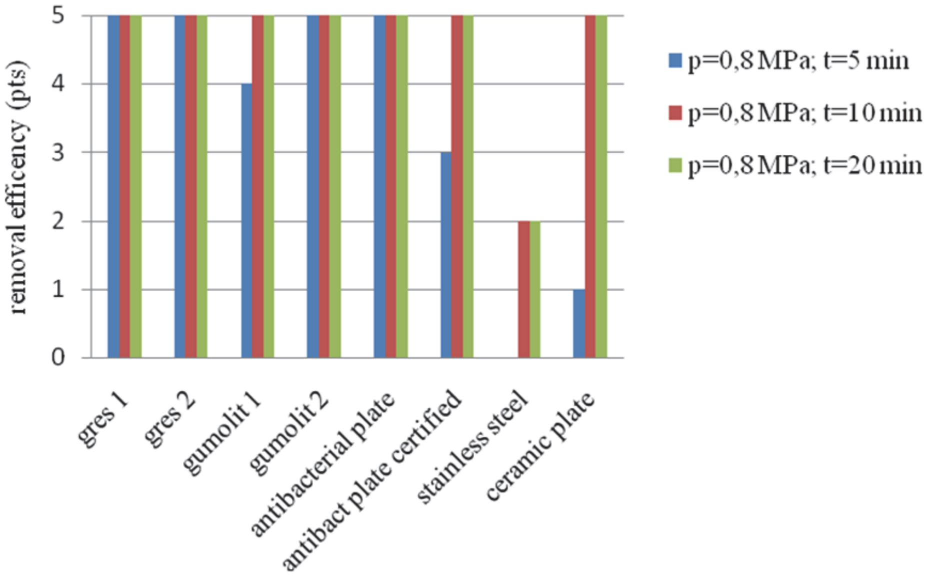

Figure 4. Effectiveness of removing protein impurities (p=0.8 MPa, t=5; 10; 20 min)

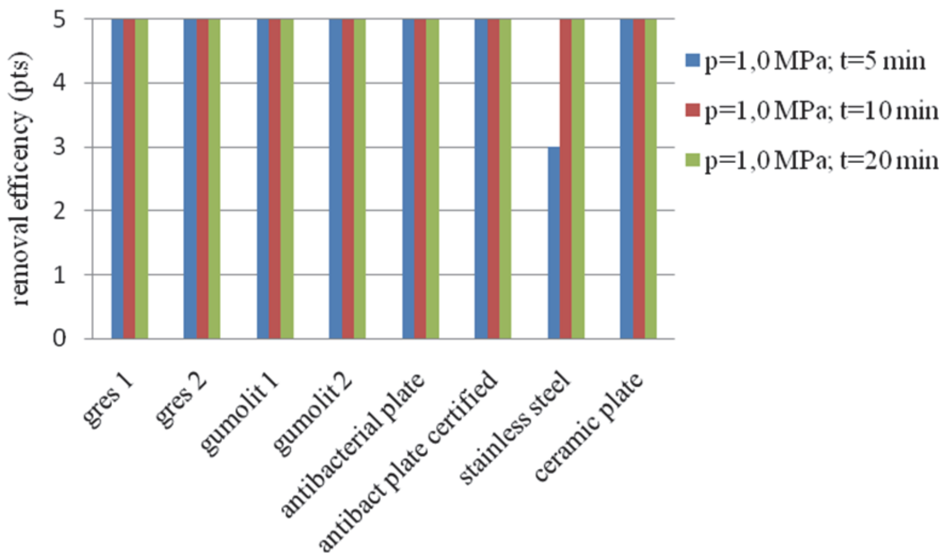

Figure 5. Effectiveness of removing protein impurities (p=1.0 MPa, t=5; 10; 20 min)

Statements and conclusions

Based on the survey the following statements and conclusions were formulated:

1. The parameters of the process are an important factor in determining the effectiveness of cleaning with the foam cleaning technique. The air pressure has the greatest impact on the cleaning process.
2. The foam produced at a pressure of 1.0 MPa, is the most persistnet foam which removes proteins from all test surfaces. Application of pressure of less than 0.8 MPa does not guarantee adequate quality of foam, which would remain on the surface for appropriate time.
3. Protein impurities are the most easily removed from surfaces such as tiles, antibacterial tiles, linoleum. Stainless steel is a surface, from which it is difficult to remove protein impurities.
4. The foam cleaning process parameters, in which all the protein impurities are removed is: 10 minutes of maintaining foam formed at the pressure of 1 MPa.

In food factories foam washing is widely used because of the simplicity and accuracy of the process. The ideal would be to use different cleaning instructions (different pressures, times, etc.) For different surfaces, but this results in the creation of many documents. The study shows that the development of the washing instructions for stainless steel surfaces with the appropriate parameters of the process ensures that any other surface (the surface of the respondents) will also be washed.

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BADANIE SKUTECZNOŚCI USUWANIA ZANIECZYSZCZEŃ BIAŁKOWYCH Z RÓŻNYCH POWIERZCHNI TECHNIKĄ MYCIA PIANOWEGO

Streszczenie. W pracy przedstawiono wyniki badań dotyczących skuteczności usuwania zanieczyszczeń białkowych metodą mycia pianowego z 8 różnych powierzchni wykorzystywanych w przemyśle spożywczym (gres, gumoleum, płytki antybakteryjne i tradycyjne, stal nierdzewna). Powierzchnie zanieczyszczano białkiem pochodzącym z mleka i białka jaja kurzego, a następnie poddawano procesowi mycia przy zmiennych parametrach ciśnienia sprężonego powietrza i czasu kontaktu środka myjącego z badaną powierzchnią. Na podstawie wyników badań stwierdzono, że największy wpływ na skuteczność usuwania zanieczyszczeń białkowych ma ciśnienie sprężonego powietrza.

Słowa kluczowe: higiena, mycie pianowe, zanieczyszczenia białkowe, skuteczność mycia