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WORK SAFETY IN THE MILL - CASE STUDY

Klaudia Peniak[a], Krzysztof Nowacki[b]

[a] Silesian University of Technology, Department of Production Engineering, Krasińskiego 8, 40-019 Katowice. e-mail: peniakklaudia18@gmail.com (K.P.)
[b] Silesian University of Technology, Department of Production Engineering, Krasińskiego 8, 40-019 Katowice. e-mail: krzysztof.nowacki@polsl.pl (K.N.), ORCID 0000-0003-2925-084X

* *Corresponding author: e-mail:* krzysztof.nowacki@polsl.pl

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ABSTRACT

In many cases, old working mills, use machines that are several dozen years old, which are not adapted to the safety requirements. Their use may result in an accident at work. The article presents a case study of the work safety assessment in an old mill. The analysis was carried out with the use of a proprietary checklist, taking into account the current safety requirements. Non-conformities that were identified as the results of the analysis, had an impact on the level of security. The greatest number of non-conformities concerned the fulfillment of technical requirements. Actions aimed at improving work safety were proposed. The prepared checklist is a universal tool for assessing work safety in mills in Poland.

Introduction

Grain milling is one of the oldest manufacturing process in the world, where the two predominant methods used are stone milling and roller milling. The selected technique significantly influences flour quality, dough rheological properties, and bread characteristics. Stone mills are the oldest attrition mills used for making flours, which simultaneously use compression, shear, and abrasion to grind wheat kernels between two stones. Nowadays stone mills are metal plates with composition stones attached. In the process of roller milling wheat is passed through a series of corrugated and smooth metal rollers accompanied by sifting between stages (Bayram and Durdu Öner, 2005; Cappelli et al., 2020; Carcea et al., 2019; Cheli et al., 2013).

Currently, the miller's work consists in operating and supervising electrically driven machines, which are responsible for cleaning the raw materials intended for processing and grinding the cleaned grain into flour. It is a profession that carries many occupational hazards that have a significant impact on the employee's health, so this is very important to take every action which will help with providing safety on a very high level.

One of the biggest threats to millers is flour dust. Many properties of it indicate its hazard, for example, its explosiveness or the ability to cause allergic reactions in people exposed to it. Explosiveness may occur after a mixture of dust and air comes into contact with a heat

source, this is why it is very important to removing excess flour dust and preventing it from remaining in work areas. Even if explosion is very important when it comes to the health and safety issues we mostly focused on hazards directly related to the impact of dust on the employee's body. The diseases of the respiratory system induced by occupational dusts are influenced by the type of dust, dose, duration of exposure and genetic factors. For example wheat flour is a complex organic dust with a large diversity of antigenic (flour proteins, flour parasites, silica, fungi, insects or technical additives such as enzymes) or allergic components (responsible for respiratory dysfunctions and baker's asthma) (Herxheimer, 1967; Stobnicka-Kupiec and Górny, 2017; Buczaj, 2011; Russo et al., 2019; Mohammadien et al., 2013).

Despite prevention and mitigation technology of dust explosions has progressed greatly, continual accidents with the flour dust demonstrate the need for improved knowledge in this area. Due to the possible negative impact of flour dust on people and their environment, it is important to test the miller's work safety and use appropriate protective measures, both collective and individual protection (Stobnicka-Kupiec and Górny, 2017; Buczaj, 2011; Page et al., 2010; Behrens et al.. 2013).

In order to function in a company, machinery park should be safe, and therefore adapted to legal requirements. The main research problem was the maladjustment of the age-old technology in a mill. Therefore, it was decided to elaborate a research tool to check the condition of a given object and check it on an exemplary mill, where the machines have not been changed for decades. The research was carried out in a one-man enterprise, where the technology and applied solutions were not adapted to the current legal requirements in the field of health and safety.

Descriptions of the research methods

The analysis was carried out using the proprietary checklist. A checklist is a tool supporting the analysis of the workplace condition using a set of questions asked on the basis of e.g. legal acts (Parfitt and Sanvido, 1993). The questions used during the health and safety analysis were developed in accordance with following documents:

– The Act - Labor Code (Dz.U. 2020,1320);
– Regulation of the Minister of Labor and Social Policy on general health and safety at work regulations (Dz.U. 1997,129,844);
– Regulation of the Minister of Agriculture and Food Economy on occupational health and safety in the storage, processing of cereals and production of feed of plant origin (Dz.U. 1997,76, 479).

The questions were divided into 5 areas, where the area related to general safety issues, work premises, machinery and equipment, hygienic and sanitary premises and workstations was distinguished. An audit was carried out in the mill, which included an overview of the working premises, an interview with the employer and observation of the flour production process.

Health and safety analysis in the mill technology used in the mill

Analyzed mill uses electric machines that automatically transform grain into flour (mostly wheat flour, but also whole grain flour on the special order from the customers), groats or

flakes. Grinding in the mill in question takes place in 5 stages, which take place in 4 departments (Carcea et al., 2019; Jones et al., 2015):

– "black" cleaner – impurities are removed from the grain, which, in the process of grain threshing, have accidentally got into the grain mass. These pollutants can be sand, straw, dust or weed seeds. The machine used at this stage is a grain dressing machine, where the grain is twice winded with a strong stream of air, which separates large impurities from the raw material. There is also a sieve with mesh smaller than grain through which fine impurities are sifted;
– "white" cleaner – the first layer of the grain skin is removed here along with the fine impurities, such as pollen and dust. The machine used at this stage is the hulling machine, which has a steel drum in which the grain is mixed. During the rotation of the drum, the outer layer of the processed material is rubbed off;
– grinding – the grain is ground and sieved here. This process can be carried out many times depending on the expected properties of the finished product, such as fragmentation and purity of the product. The machine used at this stage is a roller mill, which has two working shafts that rotate in opposite directions and grind the grain at different speeds;
– mixing and packaging – at this stage, mixing of many of the resulting fractions of flour is carried out in order to homogenize it and average the quality and other important parameters. The place for packing the flour is located on the ground floor of the building, where the finished products are also stored in bags and sold to final customers.

In fig. 1 the milling diagram for the analyzed mill is presented. The entire process begins on the ground floor of the building, where raw materials for the production of flour are poured onto the sieve. From here, the grains are transported with the use of vertical buckets to the 2nd floor, where then the "black" and "white" cleaning begins. After cleaning the material, grinding takes place. The semi-finished products are passed through the grinding machines several times (the exact number depends of the quality of raw materials and the expected quality of the finished product). The observation of the process shows that this stage generates the greatest amount of dust to the environment, which may be caused by the lack of hermetization of the machine, its leaky structure and the lack of covers preventing dust from penetrating outside the machine's working environment. The flour is mixed in sealed silos on the 1st floor of the building, from where the finished products are then transported with chutes to the ground floor, packed into bags and delivered to customers.

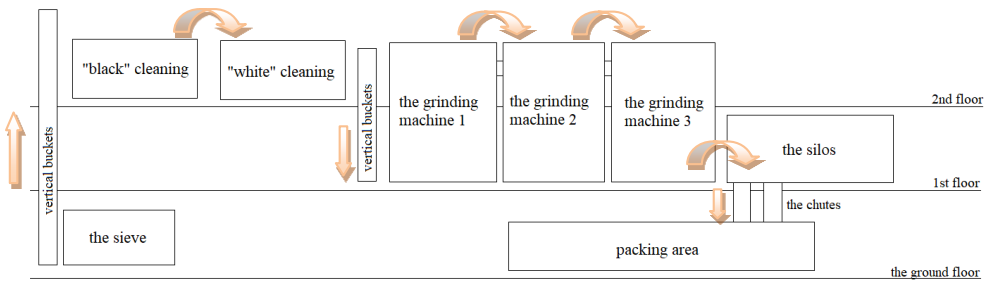

Figure1. The milling diagram

Work environment analysis results

The analysis of the health and safety in the examined workplace was carried out with the use of a checklist prepared for the needs of the analysis, which contains 35 questions divided into 5 areas (general safety issues, work premises, machinery and equipment, hygienic and sanitary premises and workstations was distinguished). Whole checklist with answers is presented in table 1-4.

Table 1.
Checklist prepared *for the needs of the analysis and results - General safety issues*

No.		Legal basis	Answer		
			Yes	No	Not applicable
	General safety issues				
1.	Are the workers/operators working in the mill equipped with protective measures to minimize the risks?	Art. 237^6 (Dz.U. 2020,1320)		X	
2.	Are the employees/operators working in the mill equipped with shoes and work clothes?	Art. 237^7 (Dz.U. 2020,1320)	X		
3.	Are traffic routes and transport routes properly marked?	Art. 4 (Dz.U. 1997,129,844)		X	
4.	Are the traffic routes and transport routes adequately sized?	Art. 4 (Dz.U. 1997,129,844)	X		
5.	Are the traffic routes and transport roads with the appropriate surface?	Art. 4 (Dz.U. 1997,129,844)	X		
6.	Are traffic routes and transport routes free of thresholds and steps?	Art. 5 (Dz.U. 1997,129,844)	X		
7.	Are places with hazards for employees/operators marked with visible colors and signs?	Art. 6 (Dz.U. 1997,129,844)		X	
8.	Are the fire roads, crossings and access roads easily accessible and unobstructed?	Art. 7 (Dz.U. 1997,129,844)	X		
9.	Are there designated escape routes from all rooms where employees/operators may be?	Art. 9 (Dz.U. 1997,129,844)	X		
10.	Is artificial lighting provided in all rooms at night and during the day if natural light is insufficient?	Art. 10 (Dz.U. 1997,129,844)	X		

Table 2.
Checklist prepared for the needs of the analysis and results - Work premises

No.	Question	Legal basis	Answer		
			Yes	No	Not applicable
	Work premises				
1.	Are there technical solutions used in work rooms with dusts that prevent them from getting into other work rooms and into hygienic and sanitary rooms?	Art. 15 (Dz.U. 1997,129,844)		X	
2.	Are the floors in rooms and roads in construction facilities stable, even, non-slip, non-dusting, abrasion-resistant and pressure-resistant, as well as easy to clean?	Art. 16 (Dz.U. 1997,129,844)	X		
3.	Are the working rooms free from harmful factors have a height of at least 3 m?	Art. 20 (Dz.U. 1997,129,844)	X		
4.	Do rooms with harmful factors have a height of at least 3.3 m?	Art. 20 (Dz.U. 1997,129,844)	X		
5.	Is it possible to access permanent work spaces at different levels with a non-slip fixed staircase or ramp?	Art. 21 (Dz.U. 1997,129,844)	X		
6.	Are there openwork stairs in dusty working rooms?	Art. 21 (Dz.U. 1997,129,844)		X	
7.	Is there access to natural and artificial light in permanent work areas?	Art. 25 (Dz.U. 1997,129,844)	X		
8.	Is adequate air exchange ensured in rooms where substances harmful to health are present, so that the maximum permissible concentrations of these substances are not exceeded?	Art. 32 (Dz.U. 1997,129,844)	X		
9.	Are the machines, from which dust can be released, hermetized or equipped with local exhausts?	Art. 34 (Dz.U. 1997,129,844)		X	
10.	Do the racks intended for storage have an adequately durable and stable structure and are they protected against overturning?	Art. 69 (Dz.U. 1997,129,844)			X
11.	When storing loose dusting materials, has a tight fence at least 0.5 m above the height of the stored material been provided?	Art. 75 (Dz.U. 1997,129,844)			X
12.	Are the walls in production and storage rooms, as well as load-bearing structures protected with a non-absorbent coating at a height of at least 2m?	Art. 17 (Dz.U. 1997,76, 479)	X		

Table 3.
Checklist prepared for the needs of the analysis and results - Machinery and equipment, Hygienic and sanitary premises

No.	Question	Legal basis	Answer		
			Yes	No	Not applicable
	Machinery and equipment				
1.	Is each machine equipped with a control element that allows it to stop completely and safely?	Art. 52 (Dz.U. 1997,129,844)		X	
2.	Are the safety-related machinery controls visible and identifiable and suitably marked?	Art. 52 (Dz.U. 1997,129,844)		X	
3.	Are the machines equipped with easily identifiable and appropriately marked disconnection devices for all energy sources?	Art. 53 (Dz.U. 1997,129,844)		X	
4.	Are all hazardous moving parts and other machine parts covered or equipped with other effective protective devices up to a height of at least 2.5 m from the floor (platform) of the workplace?	Art. 55 (Dz.U. 1997,129,844)		X	
No.	**Hygienic and sanitary premises**				
1.	Does the employer provide employees/operators with personal hygiene products, the amount and types of which should be adapted to the type and degree of contamination of the body during specific work?	Art. 115 (Dz.U. 1997,129,844)	X		
2.	Do employees/operators have access to rooms equipped with showers?	Art. 32 (Dz.U. 1997,129,844)	X		

Table 4.
Checklist prepared for the needs of the analysis and results - Workstations

No.	Question	Legal basis	Answer		
			Yes	No	Not applicable
	Workstations				
1.	Are raw materials, finished products, auxiliary materials and waste not stored at workplaces in	Art. 46 (Dz.U. 1997,129,844)	X		

No.	Question	Legal basis	Answer		
			Yes	No	Not applicable
	Workstations				
	amounts greater than those resulting from technological needs?				
2.	Is production waste at the workplace successively removed?	Art. 46 (Dz.U. 1997,129,844)	X		
3.	Is there a safe and convenient access to each workstation, the height of which along its entire length is not less than 2 m?	Art. 48 (Dz.U. 1997,129,844)	X		
4.	Is there a place to rest in a sitting position when working in a standing or walking position?	Art. 49 (Dz.U. 1997,129,844)	X		
5.	Have any steps been taken to eliminate the need for manual handling of loads?	Art. 62 (Dz.U. 1997,129,844)	X		
6.	Are the permissible standards for manual transport complied with during transport work?	Art. 63 (Dz.U. 1997,129,844)	X		
7.	Are the permissible standards for the load-bearing capacity of the transport equipment complied with during transport work?	Art. 64 (Dz.U. 1997,129,844)	X		

Analysis of the results

In the course of the analysis, 10 incompatibilities were identified, which were divided into 4 main groups (Fig. 2), such as:

– building solutions – stairs that did not meet the legal requirements for the work of dusty believers. They were made of wood, the steps were narrow and unstable;
– protective measures – where there is a lack of personal protective equipment for employees/operators, as well as the lack of covers on parts of moving machines;
– markings – it concerned the lack of all kinds of markings of hazardous zones in which there are threats to the worker, the lack of markings of the basic control elements of machines and the lack of separation and appropriate marking (visual marking) of communication routes and transport routes in the building;
– technical measures – any inconsistencies related to the lack of solutions preventing dust from entering other rooms, the lack of isolation of the machine emitting dust from its immediate surroundings, the lack of control elements allowing for complete and safe stopping of the machines in use and the inability to easily disconnect only one of the machines from energy sources

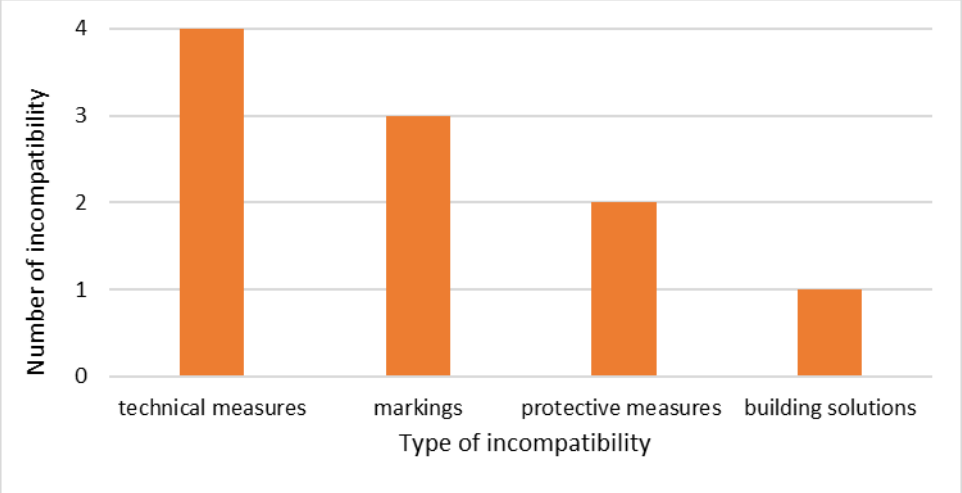

Figure 2. The number of incompatibilities in the selected groups

According to the data presented in Figure 2, the most numerous group were incompatibilities related to the technical means used (4 incompatibilities), they concerned the machines used and their protections. The second group in terms of the number of revealed non-conformities was the one concerning markings (3 incompatibilities), the third group concerned protective measures applied in the workplace (2 incompatibilities), and the last group in terms of the number was related to construction solutions (1 incompatibilities). For the identified incompatibilities, corrective actions were proposed, presented in Table 5.

Table 5.
Proposals of corrective actions in the mill

No.	Type of incompatibility	Corrective actions
1.	technical measures	- hermetic doors between work premises; - hermetic covers around machines; - local extractors for machines; - signs informing about the obligation to close doors between rooms; - conversion of the machine driving system from one main engine to a separate power supply for each machine; - equipping each machine with control elements allowing for complete and safe stopping; - modification of the machine driving system to enable easy disconnection of the selected machine from the energy sources; - marking of the main switch (inscriptions, colors).

No.	Type of incompatibility	Corrective actions
2.	markings	- designation of communication routes and transport routes with appropriate dimensions, surfaces and without thresholds and steps; - introduction of signs and pictograms; - fencing off the areas of movement of workers, means of transport and machine work areas; - marking of control elements (inscription, colors).
3.	protective measures	- equipping the worker with protective equipment, such as dust masks, goggles, a protective cap, shoes with non-slip soles and hearing protectors; - designating zones in which the PPE must be used and informing all workers of the new requirements; - providing cover for moving parts to a height of at least 2.5 m; - training in the importance of using protective measures.
4.	building solutions	- openwork overlays for stairs, mounted with fasteners requiring an additional tool for removal; - removing concrete stairs that do not meet the standards and replacing them with openwork stairs with steps of appropriate dimensions; - edge marking with yellow and black tape indicating the first and last step and low-slung foot.

In the literature on the subject it is difficult to find information on the methodology of dealing with old mills that do not meet legal requirements. The analysis made in such places is very important, because due to negligence, many accidents may occur, with disastrous consequences. The results show that many actions must be taken so that the enterprise could continue to function and not cause a threat to health or life of operators and persons in the building. The proposed corrective actions not only improve the safety of the machinery but also increase awareness.

In the analyzed case the employer decided that changes are not necessary due to the absence of an accident and health hazards for many years of his work. This situation gives great opportunities to spread awareness, especially knowing that in small enterprises there is no obligation to establish a health and safety unit.

Conclusions

1. During the analysis, 10 incompatibilities with legal requirements were identified.
2. The largest number of incompatibilities related to technical measures (4 identified incompatibilities). Second in terms of quantity were deficiencies in markings (3 identified incompatibilities) and in protective measures (2 identified incompatibilities) and the least numerous were incorrect building solutions (1 identified incompatibilities).
3. Thanks to the use of horizontal buckets, the need for manual transport work has been significantly reduced, which has minimized the risks associated with them.

4. Due to the high number of incompatibilities related to technical measures and construction solutions (5 out of 10 incompatibilities), it was noticed that the main cause of incompatibilities was the poor technical condition of the building. The second part of incompatibilities related to markings and protective measures was caused by the employer's lack of adequate knowledge and awareness.
5. The presented checklist is dedicated to a specific process and machine park, questions were raised based on situation in the analyzed mill. The methodology of the analyzes may be used in similar cases in the future.

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Bezpieczeństwo pracy w młynie - studium przypadku

Streszczenie. W wielu przypadkach stare, pracujące młyny, wykorzystują kilkudziesięcioletnie maszyny, które nie są dostosowane do wymogów bezpieczeństwa. Ich użytkowanie może skutkować wypad-kiem przy pracy. W artykule przedstawiono studium przypadku oceny bezpieczeństwa pracy w starym młynie. Analizę przeprowadzono z wykorzystaniem autorskiej listy kontrolnej, uwzględniającej aktualne wymagania bezpieczeństwa. Niezgodności, które zostały zidentyfi-kowane w wyniku analizy, miały wpływ na poziom bezpieczeństwa. Najwięcej niezgodności dotyczyło spełnienia wymagań technicznych. Zaproponowano działania mające na celu po-prawę bezpieczeństwa pracy. Przygotowana lista kontrolna jest uniwersalnym narzędziem do oceny bezpieczeństwa pracy w młynach w Polsce

Słowa kluczowe: zagrożenia, pył mączny, młyn, młynarz, zdrowie i bezpieczeństwo