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Berufsgenossenschaft
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Expert committee information sheet

Protection systems on machine tools

Against flame ejection when using flammable metal working fluids

A great quantity of flammable, non water-miscible metal working fluids (MWF) is being used in the metal working industries, to achieve an efficient and economic production. This trend brings the topic of fire and explosion protection and prevention for machine tools to the fore. Depending on the type of machining, violent reactions of the MWF/oil-air mixture may occur in the interior of the machine tool which can be followed by a fire and severe accidents with burns and high material damages due to fire propagation.

The ignition of the MWF/oil-air mixture in the machining room (e.g. by sparks, hot surfaces) may result in violent flame ejections in the working and operating area of the machine. If no adequate measures are taken, flame propagation into the extraction has to be taken into account.

For a better protection of the machine operator against flame ejections from machine openings, such as e. g. door labyrinths and unloading openings and against flame ejections into the extraction circuit, protection systems are used which are described in the following.

Figure 1: Flame ejection in the door area at the ignition of the MWF/oil-air mixture in the machining room

1 Protection systems against flame ejections in the extraction

At the ignition of the MWF/oil-air mixture within the machining room in the course of practical tests carried out at the IBEXU Institute, several flame propagations into the extraction of the machine could be observed without having taken adequate measures. Measures such as e. g. the mounting of a baffle plate in front of the extraction opening showed initial success in the fight against fire propagation.

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Figure 2: Flame propagation in the extraction

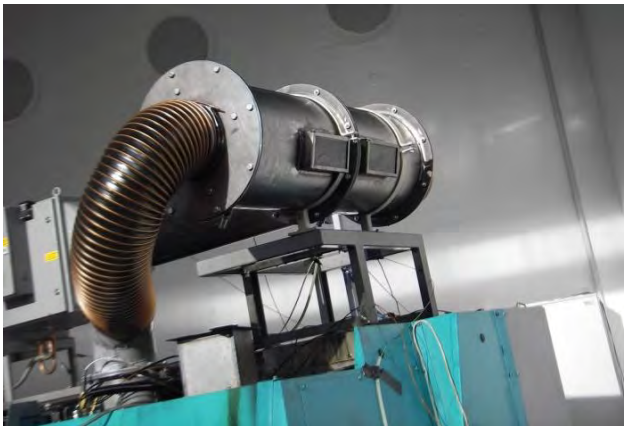

Figure 3: Flame arrester by INDEX/Büchel

By applying the principle of multiple deflection and expansion (figures 3, 4), a device has been developed which is resistant to flame propagation and intended to be installed in extractions. It is suitable to prevent flame propagations from single machines into central extraction systems.

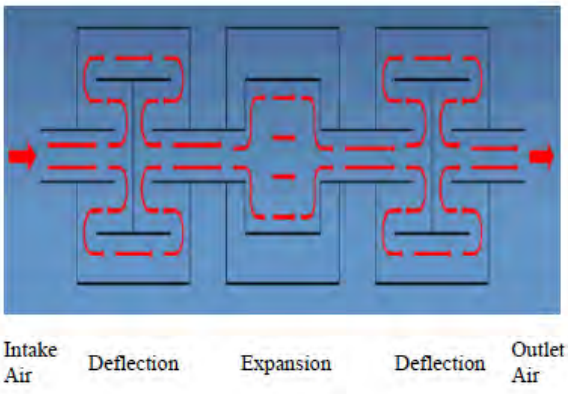

Figure 4: Flame arrester schematic drawing

The best effect has been achieved by the combination of baffle plate with downstream flame arrester. Besides the prevention of flame propagations, the ingress of chips/dirt and metal working fluid splashes has also been considerably restricted.

2 Protection systems against flame ejections into the operating area

The ignition of the MWF/oil-air mixture in the machining room with missing or unfavorable labyrinth geometries resulted in violent flame ejections in the operating area of the machine. By the development and the application of re-engineered door labyrinths, it could be managed to largely prevent flame ejections at the machine tool into the operating area. The principle of multiple deflection and expansion (figures 5, 6) has been applied in this case as well.

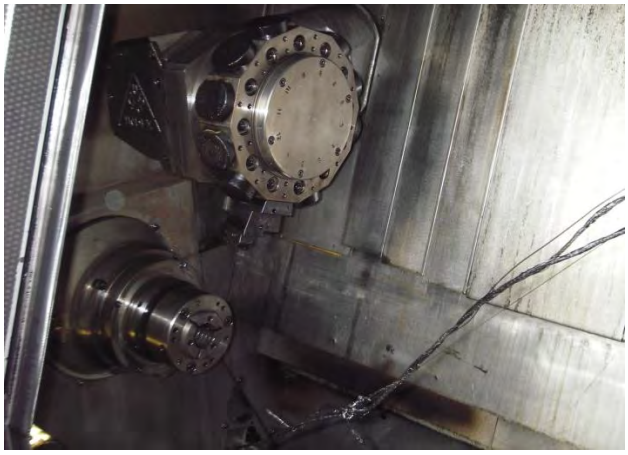

Figure 5: Improved labyrinth sealings

The labyrinth sealing shown in figure 6 works on the principle of a multiple series-connected deflection and expansion of the occurring flames.

By using suitable labyrinth sealings at doors of machine tools, flame ejections into the operating area can be prevented to the greatest extent.

For this, labyrinth sealings with several deflections of the flame path and gap widths of ≤ 2 mm have been proven of value.

Design principles for labyrinths resistant to flame propagation:

- Gaps which narrow in case of sudden pressure increase in the interior of the machine
- Gap width at narrow points max. 2 mm
- At least 2 x 180° deflection of flow
- Adjustment means for gap (adjustability)
- No use of flammable materials (e. g. brushes)
- Escape direction not directly towards the operator
- Safeguarding of crushing and shearing points by suitable measures (e. g. edge protection)

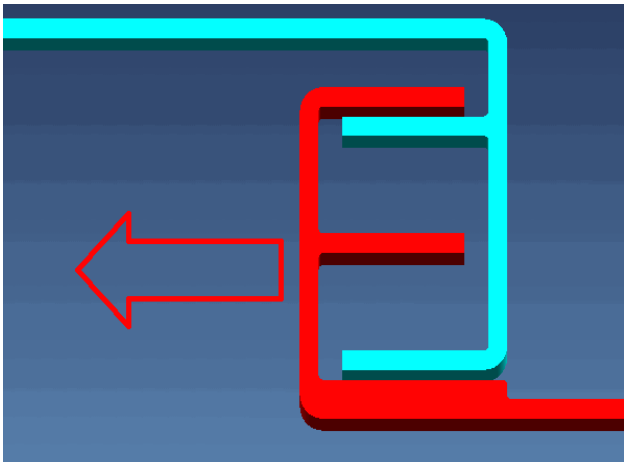

Figure 6: Improved labyrinth sealings: schematic drawing

3 Safe unloading of finished parts from machine tools

Modern machine tools, for example turning machines and turn-mill centers, are frequently used to machine workpieces completely. In this process, a raw piece is fed to the machine at the beginning of the machining process which is unloaded as finished product after machining.

Unloading these workpieces from the machines is normally done by automatic means. They are equipped with conveyor belts or chutes by means of which the finished parts are conveyed out of the machining room or operating room of the machine.

Since the unloading of parts mostly takes place in parallel time to primary machining, i. e. during machining of the next raw piece, machine operators or ancillary staff may be exposed to hazards at the unloading points. In order to protect the machine operators against hazards at the unloading points, e. g. against ejecting flames, examples for an inherently safe design of the unloading devices are described in the following which ensure sufficient personnel protection. It is necessary to design the gaps the unloading means go through in such a way that only one side is open at a time - the one of the machine or that towards the surrounding. Thus, the atmosphere within the machining room is not carried outside and there exists a high level of safety against incidents occurring inside the machine which may have an impact on the surrounding.

As solution serves the approach to separate the transfer area reciprocally from the machine's machining room or from the surrounding respectively.

Figure 7: Loading and unloading station of raw and finished parts on a multispindle automatic lathe

The area out of which the workpiece is conveyed from the machining room shall be alternately separated from the machining room and the surrounding. This separation can be implemented by the following means:

- Application of systems which are accessible from two positions but only from one side at a time, comparable with rotary plates of bank counters or bank cash drawers (Figure 7).
- Opening of the transfer room by the unloading device at the time of transfer with simultaneous separation of the surrounding area.
- Provision of a transfer room in case of which the workpiece is conveyed to the outside in a closed channel after the finished parts have been transferred. This principle can be easily implemented by means of customary conveyor belts which are provided with crossbars (Figure 8).

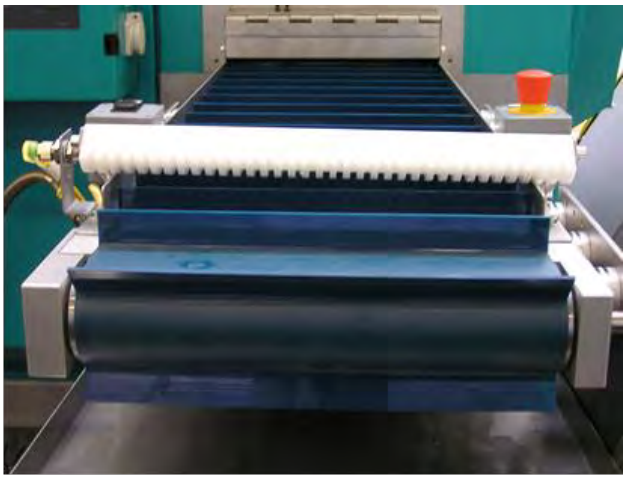

Fig. 8: Conveyor belt with crossbars, covered at the machine entrance

In order to be applied in machine tools, it is necessary to carefully examine these means as to their practicability and long-term functional safety. Furthermore, these measures have to withstand the conditions within the machining room and the requirements of the surrounding. This means for the machining room that a chemical resistance to all occurring media has to be ensured and that the temperatures in the working room–both the temperature of the atmosphere as well as that of the workpiece– are endured. The most important point is that the total equipment has to withstand the mechanical attack of ejecting chips in the long term.

Machines at which the relevant measures have been implemented as shown in figures 7 and 8, demonstrate that it is possible to technically implement all requirements for conveying and unloading means on a high quality level. This further improves the protection of people who work in the immediate vicinity of the machine.

4 Summary and limits of application

The Fachbereich Holz und Metall (Expert Committee Woodworking and Metalworking) is composed of representatives of the German Social Accident Insurance Institutions, federal authorities, social partners, manufacturers and users. It is based on experience gathered by the Expert Committee Woodworking and Metalworking.

This information sheet has been prepared by the Fachbereich Holz und Metall, Sachgebiet Maschinen, Anlagen, Fertigungsautomation und –gestaltung (Expert Committee Woodworking and Metalworking, subcommittee Machinery, Plants, Automation and Design of Manufacturing Systems). It is intended to provide orientation to designers, manufacturers as well as to safety officers, production engineers and users of metal working machinery how the detailed requirements of the European standards in relation to the provisions of the Machinery Directive are put into practice.

This expert committee information sheet replaces the same-titled draft version (10/2011). Further information sheets of the Woodworking and Metalworking Expert Committee can be downloaded from the Internet [1].

As to the aims of the expert committee information sheets, please refer to information sheet no. 001

Bibliography:

[1] Internet: www.dguv.de/fb-holzundmetall Publikationen oder www.bghm.de Webcode: <626>

[2] BGI/GUV-I 719 E Machine Tool Fire and Explosion - Prevention and Protection, April 2009 (revision 3/2012)

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The pictures shown in the expert committee information sheet have been kindly provided by:

Figure 1: BGI/GUV-I 719 [2]
Figure 2: Brandversuche bei IBExU, Freiberg
Figure 3, 4, 5, 6, 7,8: Fa. INDEX, Esslingen

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