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SOME CONSIDERATIONS ON LABOR SAFETY OF ION NITRIDING OPERATION

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Abstract: *This paper aims to analyze the hazards in carrying out ion nitriding technology. Based on experience gained during 30 years of using this technology, the authors propose a classification of hazard according to their seriousness and a series of solutions to eliminate hazards of occupational accidents and professional illness. This paper is a starting point that security is an ongoing process and that risk assessment is an obligation for any employer.*

Key words: *ion nitriding, hazard, risk assessment.*

1. Introduction

Plasma or ion nitriding has been studied and used industrially for more than 40 years [1-5], [14], [15], but the technology was not used to its full potential. Although technology is considered a safe and environmentally friendly, ion nitriding technology has many accidention dangers, occupational illness and environmental pollution.

Activities by heat treatment, and implicitly ionic nitration generates significantly risks.

They are a consequence of:

- materials used in the process;
- bottled liquefied or pressurized gas (NH_3 - ammonia, H_2 - hydrogen, O_2 - oxygen, CH_4 - methane etc.;
- liquids for degreasing-washing (trichlor ethylene, perchlorethylene);
- the manipulation of parts;
- technology etc. [9], [16], [17].

It is therefore justified the classification of jobs related ion nitriding technology as dangerous places.

Activity to ensure safety at work in the fields of ion nitriding involves: identifying hazards, risk prioritization, risk assessment and analysis, preparation of action plan to prevent accidents at work, occupational illness and environmental pollution.

Management of safety and health work should be a continuous process and must be integrated into the overall management of the firm [6], [10-13], [18].

The purpose of this paper is to identify and prioritize the main dangers, assess risks and provide a range of solutions to eliminate the dangers of accidents at work and occupational illness.

2. Identification and Prioritization of Hazards Associated of Ion Nitriding Technology

Dangers associated of ion nitriding technology subsumes the four elements of a work process (Figure 1).

In the case of performer the hazards are generated in particular of omissions, no

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ventilation system starts to extraction out of charge, do not use personal protective equipment (protective gloves washing and handling of parts).

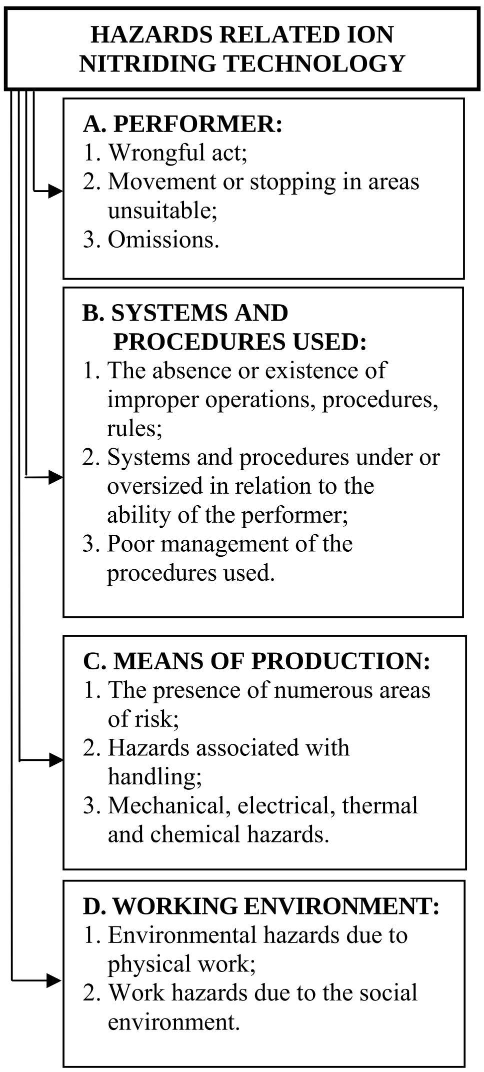

Fig. 1. *Hazards related to the work system elements* [7]

Regarding the dangers related systems or procedures used, the most common are related to the handling of individual parts which exceed the maximum permissible load on manual handling.

The most serious potential hazards are those associated with the means of production. It is primarily the danger of explosion which may occur in gas storage vessels used (liquid or gaseous ammonia, methane, oxygen etc.). Thermal hazards is reflected by burns may occur when handling parts if the charge is removed at temperatures above 50 ^{0}C. Although the ion nitriding technology provides that the parts are not removed from nitriding precincts only when the temperature parts is below 50 ^{0}C, our studies revealed that the frequent failure to meet the technological indication of a desire to shorten the cycle of ion nitriding.

Mechanical hazards encountered frequently refer to parts handling without using gloves can occur when cuts, bites, infections due to contact with sharp surfaces: sharp edges, metal chips, dirt.

Chemical hazards due to ammonia which is toxic and can cause poisoning, asphyxions or even death.

Electrical hazards caused by electric current may occur electrotraumatismes or electric shock.

The work environment is also generating occupational illness hazards especially if we do not provide adequate ventilation to remove ammonia emissions, the oil vapours vacuum pumps, vapours degreasing solvents.

Figure 2 presents a ranking of the main potential hazards that may occur in ion nitriding.

3. Appreciation and Risk Assessment

Risk appreciation is defined as a process of analysis and risk assessment conducted by qualitative and quantitative methods [8].

The main means of study used qualitative risk analysis are:

- hazard identification list;
- inspection control;
- score method;
- a preliminary hazard analysis;

- HAZOP method;
- the method What if?;
- analysis of failure modes, effects and criticality;
- fast systematic method;
- human error analysis;
- security analysis;
- energy analysis.

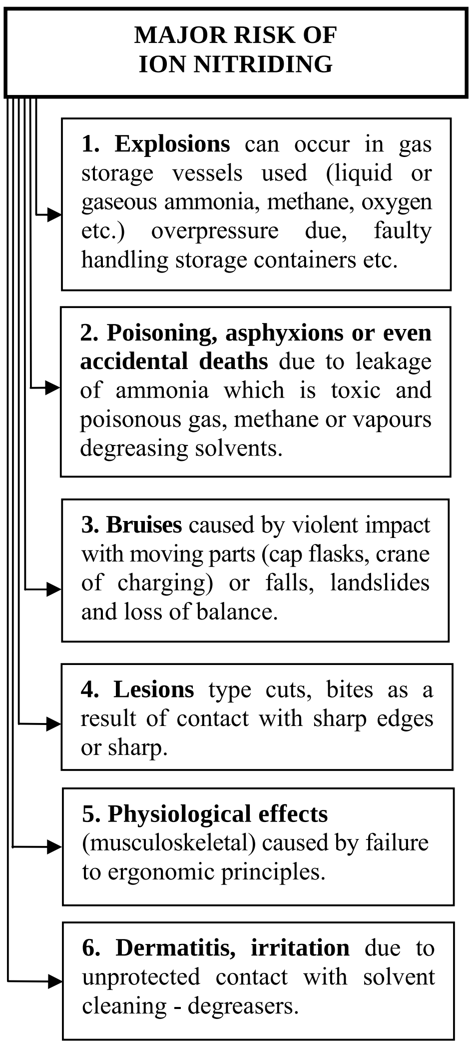

Fig. 2. *Ranking of the main potential hazards that can occur in ionic nitration*

In terms of quantitative risk analysis is used:

- HAZAN method;
- fault tree method;
- event tree method etc.

Taking into account the specific ion nitriding technology and the experience gained in risk estimation and evaluation, we recommend two methods namely method of security analysis and risk assessment of exposure to chemicals existing in the workplace for compliance with OSH requirements.

4. Risk Assessment Method for Analyzing Security

It is a method aimed at identifying risks to the production process, understanding the possible causes and propose measures for accident prevention and protection.

Under this method the risk is given by the workers exposure to vapours from the gas used: mainly ammonia and less CH_4 is used in the work atmosphere.

Risk estimation assumes that risk is a function of probability and consequence is:

$$R = P \times C. \qquad (1)$$

Under this method the probability of an accident has values from 0 when the danger is completely eliminated and 50 correspond to the maximum value of the occurrence of an accident is very likely (Table 1).

In our case we think it is quite likely to occur in an accident a year so $P = 10$.

The consequences of an accident by this method are insignificant, and $C = 0.5$ to very serious consequences $C = 100$. Taking into account previous assessments as we expected considerable consequences, so $C = 15$.

Therefore it is estimated that the risk R level have degree 150, $R = 10 \times 15 = 150$, which have code 2 on a scale of degrees of risk, that is a significant risk and this should be taken (Table 2).

Table 1

The scale of probability of occurrence and consequences of an accident

The probability of an accident appearance	The consequences of an accident
$P = 0$, the danger is completely eliminated	$C = 0.5$, minor
$P = 0.1$ very unlikely (< 1 at 10 years)	$C = 1$, very small
P = an unlikely (1 at 10 years)	$C = 5$, small
Low probability $P = 3$ (1 at 3 years)	**$C = 15$, significant**
$P = 10$ relatively probable (one per year)	$C = 40$, serious
$P = 30$ samples (one per month)	$C = 100$, very serious
$P = 50$ very likely (< 1 per month)	–

Technical measures are recommended:

- use an ammonia sensor that is coupled with an automatic closing valve cylinder ammonia ammonia;
- improving the ventilation by creating of a general ventilation;
- automation and mechanization of crane for charging or decharging. Organisational measures;
- appropriate labeling of working gas cylinders;
- limiting access to laboratory;
- better working instructions.

Scale degrees of risk Table 2

Estimate	Code	Description
$R < 20$	0	Negligible risk
$20 < R < 70$	1	Risk acceptable and is not need to be taken measures
$70 < R < 200$	**2**	**Significant risk, it is advisable to take measures**
$250 < R < 400$	3	High-risk must be taken measures
$R > 400$	4	Unacceptable risk must be taken immediately measures.

Other measures include:

- renewal of personal protective equipment (gas mask, protective gloves when handling and washing parts);
- increased caution when handling ammonia.

Hygienic measures:

- providing a first aid station;
- providing regular medical check workers;
- providing an antidote food (milk) for workers exposed to ammonia.

5. Method for Assessing the Risks of Exposure to Chemical Agents

Ammonia is in Class 4 toxic hazard, T - very toxic by inhalation R26.

Potential exposure classes are:

- C - quantities used - 2;
- Df - the duration and/or frequency of operations - 2;
- operating mode - 1.

Exposure class:

$$E = Df \cdot C \cdot A = 2 \times 2 \times 4 = 4,$$

so E is average.

Using the risk ranking table (class exposure - risk level), resulting class of risk concern when there are two ways:

- avoid exposure is impossible thanks to technology, and
- taking preventive measures, priority being protection of the collective.

The measures are similar to above point.

6. Conclusions

Documentation of safety and health at work in ion nitriding sector requires a good theoretical risk assessor knowledge of legislation, EU directives etc. Framework. Any move in this direction must be based on a thorough theoretical study. Theoretical and practical studies on ion nitriding technology have enabled:

1. Identification and prioritization of hazards associated with ion nitriding technology.
2. Assessment and evaluation of risks ion nitriding technology security through analysis method and the method of assessment of risk of exposure to chemicals, CMR, biological, existing at the workplace for compliance with OSH requirements.
3. Establishment of technical, organizational, sanitary and other measures to increase the occupational safety at execution of ion nitriding technologies, avoid or eliminate risks of accidents at work and occupational illness.

Identifying and assessing the risks of accidentation in work and occupational illness, revealed a special character of this threat requires the laboratory where the need for urgent preventive measures. This work may be a working guide for security assessments and health for other jobs. The work is perfect and beginning the approach should be continued and extended to much larger scale.

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