

## USING TLV'S FOR OCCUPATIONAL HEALTH RISK EVALUATION OF SOME POLLUTANTS MIXTURES

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**abstract:** The aim of this theoretical study was to investigate the mode of occupational health risk evaluation based on external exposure limits –Threshold Limit Value's.-TLV' s. The TLV-TWA,TLV-STEL are assimilated with  $VL_8$ ,  $VL_S$  from Romanian General Norms for Work Protection (RGNWP)/2002. Two cases of synergetic- additive pollutants mixtures are discussed.

**key words:** toxic risk evaluation, dynamic pollutants mixtures, synergetic additive action .

### Introduction

The Occupational Exposures to Hazardous Chemicals is a law which requires employers to provide training and safety instruction as well as the appropriate protective equipment for employees [1]. It's pretty amazing how many occupations besides chemistry involve the use of hazardous materials. Biologists, physicians, dentists, nurses, engineers, painters, carpenters and more, all use hazardous materials in their work.

A chemical is considered hazardous if it is [2]:

- Determined to be cancer causing, toxic, corrosive, an irritant, a strong flammable or reactive.
- Assigned a threshold limit value (TLV) by American Conference of Governmental Industrial Hygienists (ACGIH).

The ACGIH has determined TLV for almost 600 chemicals, which can enter in the body by inhalation (gases, vapours, particulate mater), eye contact, skin contact/absorption, ingestion. The TLV' s are established for the average person equating to a 150 pounds male, age 25-44. TLV' s are generally reviewed and up-dated annually. They are different types of TLV measurements. We consider only: TLV-TWA (threshold limit value-time weighted average) which is time –weighted average concentration for a normal 8 hour work day (a 40 hour work week) to which worker can be repeatedly exposed without adverse effects .This external exposure limit can be assimilated with  $VL_8$  from RGNWP posted in 2002 [1]. TLV-STEL (threshold limit value-short term exposure) is the maximum concentration to which worker can be exposed for a continuous period of 15 minutes without probability of experiencing irritation, chronic or irreversible damage or narcosis

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(stupor or unconsciousness) to a sufficient degree. The only four 15 minutes exposures per day are permitted with a least 60 minutes between exposure periods [3]. This external exposure limit can be assimilated with  $VL_s$  from 2002 RGNWP [3]. The TLV's are expressed in  $mg/m^3$  or ppm. The threshold limit values for biological media are defined as the limit concentration for toxicants and their metabolites in the blood, urine and other biological fluids, expired air, under those is not possible risk(or prejudice) for health or work capacity for those exposed [4]. The biological limit values present a great importance in diagnosis of occupational diseases [1]. Two type of relationship are in use: *exposure – effect* and *exposure-response* (% of individual which present a effect from total of those exposed) [3].

In this work we try to use RGNWP/2002 [5,6] to evaluate occupational health risk for some pollutants mixtures.

## Results and Discussion

It is necessary to remember how these rules are applied in the case of health risk evaluation for individual contaminants. Historically, contaminants have been considered individually when setting ambient air quality standard. The air contaminants that have been designed as criteria pollutants comprise only a tiny fraction of those present, but they receive a great deal of attention [5].

A substance present in occupational environment which is mentioned in the RGNWP list [6] with only  $VL_s$  can determine *acute/cumulative* without threshold effects.

Those substances for which are mentioned with both  $VL_s$ ,  $VL_8$  determined *acute*, *under acute* and *chronically* effects. For this case is necessary to calculate medium time average concentration for 8 hours exposure.

For substances which are mentioned supplementary symbols (C- *cancerous*, p C-*potential cancerous*) the toxic risk is present for concentrations under  $VL_s$  or  $VL_8$ . In this case is imposed use of *biological internal exposure* indicators.

Working people have always been exposed to *dynamic mixtures* of substances in the air [5], so evaluation of mixtures is a rational approach to protecting health.

In the case of mixtures formed by *indifferent* pollutants evaluation of the health risk is individually, using previous resumed technique. For the case of mixtures with *antagonistic* components, their combined effect is difficult to evaluate [1]. For *synergetic- additive action mixtures* may be two situations:

- separate measurements for every pollutant
- global measurements data are available.

For the first case it must calculate *global toxicity index* (GTI) based on sum of n time averaged concentrations corresponding for n pollutants present in system reported to the minimal  $VL_s$  (of the most toxic pollutant). If  $GTI > 1$  then the toxic risk is present [1].

In the second case the mixture can be *indefinitely*, when global dose is compared with minimal VL, or *definitely* (properties of every component of mixture are known). In this last case we calculate mixture concentration  $C_x$  after formula:

$C_x = VL_x / (P_1/VL_1 + P_2/VL_2 + \dots + P_n/VL_n)$ , where  $VL_x$  correspond to VL of the mixture and  $P_1, P_2, \dots, P_n$  – the components fractions in the mixture.

The results are compared with  $VL_x$ . When pollutants have different mechanism of action and act on different receptor it is a *synergetic without addition action* mixture (or true dynamic mixture) - which is more difficult to evaluate [7,8].

### **Case study I**

In the chemical laboratory a woman worker is exposed at inorganic acid vapours as follows:

2h at  $H_2SO_4$   $c=0.8 \text{ mg/m}^3$

2h at  $H_2SO_4$   $c=1 \text{ mg/m}^3$  and HCl with  $c=0.4 \text{ mg/m}^3$

1h at HCl with  $c=4.5 \text{ mg/m}^3$  and  $HNO_3$  with  $c=4.9 \text{ mg/m}^3$

3h- not toxicants exposure.

How can interpret these data for health risk evaluation?

*Solution*

This is a case of mixtures where individual measurements are disposable.

RGNWP list/2002 shows the following  $VL_s$ :

Position. 28 for HCl  $VL_s=15 \text{ mg/m}^3$ ;  $VL_8=8 \text{ mg/m}^3$

Position. 43 for  $H_2SO_4$   $VL_s=1 \text{ mg/m}^3$ ;  $VL_8=0.5 \text{ mg/m}^3$

Position. 36 for  $HNO_3$   $VL_s=2 \text{ mg/m}^3$ ;  $VL_8=1 \text{ mg/m}^3$

We may observe that for every pollutant individual concentration aren't higher than  $VL_s$

We calculate the medium time averaged concentrations for three studied pollutants:

$$C_{H_2SO_4} = (0.8 \cdot 2 + 1 \cdot 2) / 8 = 0.45 \text{ mg/m}^3$$

$$C_{HCl} = (0.4 \cdot 2 + 4.5 \cdot 1) / 7 = 0.66 \text{ mg/m}^3$$

$$C_{HNO_3} = 4.9 \cdot 1 / 8 = 0.61 \text{ mg/m}^3$$

$$\text{Then } C_{H_2SO_4} + C_{HCl} + C_{HNO_3} = 1.72 \text{ mg/m}^3$$

Then  $TGI = 1.72 / VL_s \text{ minimal} > 1$ . Toxic risk exists!

### **Case study II**

In the dyes shop (company) the worker is exposed in the working day in conformity with professional schedule as follows:

2h to ethyl acetate  $c = 400 \text{ mg/m}^3$

2h to methyl acetate  $c = 275 \text{ mg/m}^3$  and ethyl acetate  $c = 450 \text{ mg/m}^3$

2h to methyl butyl acetate  $c = 500 \text{ mg/m}^3$  and ethyl acetate  $c = 400 \text{ mg/m}^3$

2h – isn't toxicants exposure.

What is the toxic occupational risk?

*Solution*

Compare the values of individual concentrations with  $VL_s$  extracted from RGNWP/2002 list:

At position 10 for methyl acetate correspond  $VL_s = 600 \text{ mg/m}^3$ ;  $VL_8 = 200 \text{ mg/m}^3$

At position 7 for ethyl acetate correspond  $VL_s = 500 \text{ mg/m}^3$ ;  $VL_8 = 400 \text{ mg/m}^3$

At position 13 for methyl butyl acetate correspond  $VL_s = 540 \text{ mg/m}^3$ ;  $VL_8 = 270 \text{ mg/m}^3$

We calculate the individual time averaged concentrations for the three solvents:

$$c_{\text{methyl acetate}} = 2.275/8 = 68.7 \text{ mg/m}^3$$

$$c_{\text{ethyl acetate}} = (2.400 + 2.450 + 2.400)/8 = 312 \text{ mg/m}^3$$

$$c_{\text{methyl butyl acetate}} = 2.500/8 = 125 \text{ mg/m}^3$$

The global concentration is:  $68.7 + 312 + 125 = 505 \text{ mg/m}^3$

Then  $TGI = 505/VL_s$  minimal  $> 1$ .

Results a health toxic risk based on synergetic additive action!

## Conclusions

1. Evaluation of toxic risk for the pollutants mixtures is a rational approach to protecting health.
2. We solved two cases of synergetic additive action in inorganic and organic pollutants mixtures.

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