ORIGINAL ARTICLE

Evaluation of Exposure to the Radiation and the Effect of Using Eye Shield by the Employees at Iron works

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ABSTRACT

Background: Different furnaces and the hot process in the iron industry create some radiations that have some undesirable effects on health conditions of the employees.
Aim: The present study aims to investigate into the occupational exposure and the effect of using eye shields at the work stations of the employees where they are exposed to infrared or ultraviolet.
Methods: The present study was conducted in one of the iron industries of Iran in 2018. In this investigation, two models of HANGER device namely EC1 –IR and EC1 UV-A were employed to measure the radiations in three positions, that is, behind the shield, in front of the shield, eye protection safety glasses and hand skin and the results were analyzed using SPSS 20 software.
Results: In the present study, 21 work stations including 66 employees were selected to measure the radiations. The infrared was measured in 63 different areas where it was less than the permissible limit only in 5 cases (behind the shield or eye protection safety glasses). From among the amounts of the ultraviolet that was measured in 21 areas, it was greater than the permissible limit only in one case.
Conclusion: The eye protection equipment decreases the exposure of employees to the radiations significantly (p=0.001). The appropriateness of the personal protection equipment can help the person to have an effective role in protection against the infrared and ultraviolet radiations. The required training about the dangers that the radiations pose to the eyes and skin should be provided and the eyes and skins of all employees should be examined regularly.
Keywords: Radiation, occupational exposure, industry

INTRODUCTION

The humans are always exposed to the radiation of ionizing and non-ionizing radiations originating from different sources. The use of productive radiation sources has expanded extensively which has brought about greater contacts among people[1,2]. The radiation of the wavelengths between 780 nm to 1mm in the electromagnetic spectrum is known as the infrared radiation[3]. The infrared radiation is absorbed by almost all structures of the eyes. The radiation of IR-A (770 to 1400 nm) is absorbed by the lenses and the wavelengths greater than 1400 nm (IR-C AND IR-B) are absorbed by the cornea and they are converted into heat in the cornea and cause cataracts in lenses indirectly[4]. Standing in front of the aluminum or iron furnaces does the most serious damage through infrared to the eyes and causes cataract (5). Controlling the radiations to protect the health conditions of the work force reduces the costs resulting from the injuries to the work force[6]. The ultraviolet radiation is another part of the electromagnetic spectrum beams with the wavelength of 100 to 400 nm where its wavelengths are 280 to 40 nm (UV-B AND UV-A) that are greater than other wavelengths and damage the eyes[7,8]. The exposure of the eyes to the ultraviolet radiations can lead to the cataract and damage the retina. The ultraviolet radiations can create free radicals that lead to the change in the cell protein and lipid peroxidation[9]. Recent studies have shown that the exposure of the cornea to the ultraviolet radiations and infrared makes some pathological changes in its structure[10]. The severe exposure of the cornea to the ultraviolet radiation causes conjunctivitis while the chronic and repeated exposure exerts some effects on the epithelium and anterior cornea[11]. The iron industry is one of the main industries and its employees are exposed to some harmful physical factors like noise, heat and radiations. The main radiations in the iron industry that the workers are exposed to are ultraviolet and infrared radiations[12]. Numerous studies have shown that the occupational and non-occupational exposure to ultraviolet radiation of welding and workplace infrared cause some problems such as photokeratitis, erythema, cataract, dermatitis and skin melanoma[13]. Considering the importance of occupational exposure to infrared radiation and ultraviolet in iron and casting industries due to different radiation sources including the place where the molten materials exit the electric arc and induction furnaces and transfer of radiations to internal melting pots during the casting stages, pressing and blacksmithing and also the existence of some processes such as welding, cutting, the present study aims to investigate into the occupational exposure of the employees to the radiations and to examine the effects of the eye protection equipment in ironworks factory.

METHODOLOGY

The present study is a descriptive-analytical and cross-sectional study conducted in one of the central iron industries of the country in 2018. The present study was conducted in 21 work stations with the infrared and ultraviolet radiation sources. The objective of the present study was explained to all participants whose workplace risks were measured. The demographic information of all 66 participants (age, gender, education, height and weight)

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was registered by the researcher. Different types of furnaces employed in the present study are crucible furnaces, radiation furnaces, vertical shaft furnaces, electric furnace and electron furnaces and there are three types of electric furnaces namely resistance furnace, induction furnace and electrical arc furnace. In the present study, the measurements have been taken for the 5-ton and 10-ton induction furnaces. In this investigation, HAGNER Ec1-IR instrument was employed to measure the infrared radiations and HAGNER EC1 UV-A instrument was employed to measure ultraviolet radiations. All individuals who were exposed to these radiations in the working positions were admitted to the study and all measurements were taken in the morning. Also, the measurements were taken at the points where the individuals (the eyes, hands) were exposed. The goals of the study were explained to all individuals participating in the study and the individuals were admitted to the study while giving their informed consents and having no medical records and eye surgery. The measured data was analyzed by chi-square test through SPSS20 and the effectiveness of using eye protection equipment was evaluated. The results of the measurements were compared with the permissible standard of occupational exposure level and the permissible limit was determined[14] .

RESULTS

In the present study, all occupants were male and their educational degrees were as follows: 10% holding associate degree, 51% holding diploma, 37.9 holding less than high school degrees. Other relevant demographic information was reported as follows: average age: 33.9 years, average work experience: 4.4 years. In the present study, 21 work stations with the total number of 66 personnel were considered to measure the ultraviolet and infrared radiations. The infrared was measured in 63 different points and the ultraviolet was measured in 21 different points. According to the results of measurements taken by the furnace man operating the 10-ton furnace, during his exposure time (320 min), the exposure of his hand and eyes has been greater than the permissible limit. The measurements registered in the work station of the furnace man operating the 5-ton furnace were also greater than the permissible limit (while the exposure time was the same as that of the 10-ton furnace). In the continuous casting machine work station, considering the lesser exposure time, the measured amounts of exposure of eyes in front of the shield and behind the shield and the hands were greater than the standard limit. In the work stations of 10-ton operator crane, melting furnace, CCM operator, CCM control room, CCM cutter billets of production rails, rail billet cutter except for the position behind the shield that was permissible. Measurement of the ultraviolet radiation in 21 stations showed that the CCM rail billet cutter is greater than the permissible limit (Tables 1 and 2).

Table 1: Measurement of infrared radiation

Measurement Station	Exposure time (Minutes)	Measure position		measurement mw/cm^2	Exposure limit mw/cm^2	Interpretation of results
Operator Crane 10 tons	320	Eye	Front of shield	35.2	10	More than the limit
			Behind shield	5.2	10	Less than the limit
		Hand skin		16.7	10	More than the limit
Melting furnace	170	Eye	Front of shield	12	10	More than the limit
			Behind shield	5.6	10	Less than the limit
		Hand skin		11	10	More than the limit
Operator	210	Eye	Front of shield	19.4	10	More than the limit
			Behind shield	4.5	10	Less than the limit
		Hand skin		40.6	10	More than the limit
Control room CCM	250	Eye	Front of shield	19.3	10	More than the limit
			Behind shield	0.5	10	Less than the limit
		Hand skin		20	10	More than the limit
Cutter Billets of production railsCCM	90	Eye	Front of shield	14.1	10	More than the limit
			Behind shield	6.5	10	Less than the limit
		Hand skin		20.2	10	More than the limit

Table 2: Measuring ultraviolet radiation

Measurement Station	Measurement mw/cm^2	Exposure limit mw/cm^2	Interpretation of results
Cutter billets of production rails CCM	2.1	1	More than the limit

DISCUSSION

The results of the study showed that the employees in the given industry are exposed to the non-ionizing ultraviolet and infrared radiations and some interventions should be done to reduce the exposure. The 10-ton furnace man is exposed to a greater amount of infrared radiations than the 5-ton furnace within the same period (320 min). Exposure to the infrared radiation in 5 cases infiltrates behind of protective shield that should be replaced quickly with the appropriate protective shield. The measurement of the ultraviolet was greater than the permissible limit only in the rail billet cutter and it was lesser than the permissible limit in other points. Birittain et al. concluded from the evaluation that the amount and time of exposure to the infrared radiation is greater than the permissible limit, and this match with the findings of this study[15,16]. The study of Ms. Lyndahl et al. on the employees of glass factory showed that being exposed to the infrared increases the changes leading to oldness of lenses. All employees should be equipped with the appropriate eye protector[17]. The study of Slagor et al. observed no increase in the risk of increase in cataract cases among the metal welders in Denmark who worked with arc welding from 1950 to 1985. These findings can be attributed to the effectiveness of the personal protective equipment [18]. The study of Ghanbary et al.

showed that the amount of exposure to the ultraviolet radiation is greater than the permissible limit and the exposure to the infrared radiations is greater than the permissible threshold and the interventions should be made to reduce the exposure[19]. According to the study of Zamanian et al. investigating into the exposure of the welders to the ultraviolet radiations found that the exposure, the working time when the employees were exposed was greater than the permissible limit[20]. The results of this study showed that, like those of the study conducted by Sahranavard et al., the eye protection equipment reduces the amount of exposure of the employees to the infrared and ultraviolet radiations effectively[21]. Also, it should be noted that the recommended amount of the permissible limit should not be set as the acceptable limit of exposure to the mentioned radiations. On the subject of exposure to the electromagnetic radiations, the principle of As Low as Reasonably Achievable (ALARA) has the least acceptable amount of radiation dose and this means that the exposure dose to radiation should be reduced as much as possible[22]. The efficiency of the personal protective equipment can have an effective role in protection against infrared radiations. The study of Miller et al. emphasizes the role of personal protective equipment in reducing occupational exposure dose to radiation[23].

CONCLUSION

The results of Chi-square test showed that the eye protection equipment reduces the exposure of the employees to the infrared and ultraviolet radiations (p=0.001). Some actions such as reducing the time of exposure, making enough distance between the source of radiations and the individual, separating the radiation source from the individual and enclosing him, and using the workplace clothing, gloves and eye and face protection shield with appropriate degree of darkness can be provided to lessen the severity of these radiations. The employees should also receive the required training about the dangers posed to the eyes and skin by the ultraviolet and infrared radiations and the eyes and skins of the employees should be examined regularly to prevent from the disruptions and diseases of these two important organs of the body.

Conflicts of interest: No conflict of interest.

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