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Specificities of the workflow and evaluation of the working conditions of the working main professions of industrial rubber and technology production

In the available literature there is a large number of diverse works on the assessment of the labor process and working conditions of industrial rubber production. At the same time, it is of interest and there is a practical need for a sanitary-hygienic assessment of the working conditions of workers in basic occupations who are in contact with chemical substances of a general toxic and irritant action during production. The production of industrial rubber products is based on a multistage intermittent technological process using numerous chemicals of the second, third and fourth classes of toxicity. During a work shift, production personnel is exposed to fractional and short-term exposure to toxic substances, therefore, the toxic effects of chemicals used in the industrial rubber industry to workers are enhanced, which was the purpose of the study. To assess the work process and the working conditions of the workers of the main occupations of industrial rubber production, the study of air dustiness, microclimate, and relative humidity was conducted. As a result of the research, it was established that one of the unfavorable production factors at the factory of the industrial rubber products is dustiness, air pollution, overcooling, overheating and considerable physical stress.

Keywords: industrial rubber production, technological process, toxic chemicals, dust formation, gas formation.

Currently, there is a lag in the growth of labor productivity, as evidenced by information and analytical materials about the dynamics of economic indicators in industries with harmful working conditions and hard work. Over the past decade, the share of people working in hazardous working conditions in organizations of various types of economic activity has increased significantly [1].

Certification of work places for the production of rubber products showed that the chemical factor is potentially dangerous in the studied production. In the air of the working area there were chemicals of I-IV hazard classes — dichloromethane, gasoline, styrene, benzopyrene, and sootortalc, which have a harmful effect on organs: the nervous system, blood formation organs, cause liver damage, have mutagenic properties [2].

The identification of a group of chemical factors of the production environment in the manufacture of flexible rubber products must be carried out, since aggressive media and components with irritating, sensitizing, fibro genic, carcinogenic and general toxic properties are used. Toxic stabilizers rubbers and, especially the nitrous and amino compounds of the aromatic series. Some chemicals can have a combined effect on the human body, others aggravate the effects of each other [3].

Industrial rubber production is a sub-industry of the petrochemical industry. It is characterized by high labor intensity and material consumption, due to the presence of a large number of manual operations necessary to ensure the technological process and the consumption of various materials (rubber, carbon black, etc.). Each ingredient gives rubber certain properties and it introduced into the mixture in a certain amount. Ingredients are divided into: 1) vulcanizing agents — sulfur, dithiomorpholine, zincoxide, magnesium oxide, etc.; 2) vulcanization accelerators–tetraethylthiuramdisulfide, diphenylguanidine, captax, altax, sulfonamide and etc.; 3) activators — zinc oxide and etc.; 4) antiageing agent — neozone, aldol, quinol, unglazed porcleain, acetone anil, phthalic anhydride etc.; 5) reinforcing fillers or enhancers — carbon and etc. (to impart high tensile strength and high tear and abrasion resistance); 6) inert fillers — rubarx etc. (to ensure the process of mixing rubber compound, make it mangled and spewed) 7) coloring agent — antimony compounds, cadmium sulphide and etc., 8) fluidizing agent (softening agents) — petroleum oil flux, bitumen cutback and etc. According to the degree of toxicity, chemicals used in the manufacture of rubber include II, III, IV levels of toxic: antimonous acid anhydride, sulphur dioxide, cinnamene (II level), diphenylguanidine, tetramethylthiuramdisulfide, thiazone, carbon disulfide, carbolic acid (III level), scrape, black pigment, white zinc, dibutylphthalate (IV level) [4].

The factory workers of rubber products working on the main technological lines are affected by a complex of unfavorable production factors, the main of which are unfavorable microclimatic conditions, dustiness and air pollution. During a work shift, production personnel is exposed to fractional and short-term exposure to toxic substances [5].

The impact of unfavorable factors of the working environment is aggravated by a number of negative aspects in the very nature of work: monotony, forced working posture, the burden of labor processes, etc., negatively affecting the use of labor resources of workers as a result of their early development of industrial fatigue.

The technological process of rubber production consists of 4 stages: 1) making of rubber products; 2) rubber rolling; 3) pumping and vulcanization of products; 4) labeling, packaging of finished products.

The initial part of the technological chain involved in the preparation of rubber mixture for all production sites is the preparatory workshop. Preparation of rubber products is made in the preparatory workshop at the site of the sample, where all the ingredients entering the internal rubber mixer, must be pre-hung in a certain proportion according to the technological map, since these substances are in a powdery state, and the process is often only partially sealed and the main weighing is done manually, the elevated content of toxic dust is determined in the working area. When putting the bags with ingredients and removing them from the scales, there is considerable physical exertion. Suspended rubber compound materials in certain batches enter the area internal rubber mixer, in which the internal rubber mixers type (PC250/30; 250/20 and etc.) all rubber mass is mixed. On rubber mixers, automatic mixing process control is used. When ingredients are loaded into the nutrient funnels, quite a lot of toxic dust enters the workroom, when the finished mixture is unloaded of rubber mixes — gases. From the rubber mixers the mixture enters the rollers of the type СМ-ПД-2130 600/600, located under rubber mixers on which sulfur is rolled into a composition at a temperature of 90 ºС. After mixing (for 8–10 minutes), the quality is checked, cooled in water, then folded, covered with talc in layers and sent to syringe machines. Harm when rolling is dust, noise from rotors and the effect of heat factor [6, 7]. The main professional groups of preparatory workshop workers are: hangars, operators of internal rubbers mixers, rollermen.

The next process chain begins in the form and conveyor-belt shops, separately derived from the preparatory shop. It produced at 60 ºС by machine — (НСП-90, МЧГ-125; 160) forcing rubber through the profile head. The cooled profile is laid in spoons. The central part in the chain of preparation of rubber products is the vulcanization method of formation. Molding — vulcanization on presses ПХГ-6–212/4 (Hungary), 100H/89E (Czech Republic), steam presses D-4551, by heating the blanks through the walls of the molds, with the result that the product is given a certain shape. Vulcanization is carried out at a temperature of 180–200 ºС under a pressure of 130–150 atmospheres for a period of time regulated by the flow sheet for the part. At the end of the vulcanization mode, the finished parts are unloaded from the mold into the boxes and cooled. When vulcanizing products, toxic substances are an unfavorable factor: high temperature, infrared radiation and physical exertion. The main professional groups of workers in the conveyor belt and molded workshops are: compression operators — vulcanizations, roller men, extruding machine operators, calender's operators, extrusion machine operators, integrators, transport workers. The final stage of the technological process is the control, marking and packaging of parts.

Steam and gases of toxic chemicals formed during the rubber production process are complex chemical multicomponent compounds. They mainly consist of complex organic substances formed during chemical transformations. So, the composition of vulcanization gases includes more than 150 substances of 5 groups of chemical compounds: organosulfur — 30 %, aromatic hydrocarbons — 24 %, aldehydes and ketones — 20 %, hard wax and cyclanes — 16 %, amines — 10 %. The main route of entry into the body of toxic chemicals at the factory of rubber products is inhalation. They receive: chlorine hydride, manganese oxides and hydrocarbons, petroleum benzin, thiuram, captax, mist spray and aniline.

Manganese oxides, coarse and fine aerosols of chromium oxide, sulfur dioxide, hydrogen chloride and gasoline can penetrate the skin. A significant contribution to the development of intoxication and cumulation of toxic chemicals is their intake through the mucous membranes of the eyes, upper respiratory tract and the gastrointestinal tract. Intake of harmful chemicals under production conditions can occur when ingesting dust, smoking, eating food, etc. Therefore, these toxic chemicals enter the body of the working personnel of the main occupations of rubber production, mainly in a combined way.

In the available literature there is a large number of diverse works on the assessment of the labor process and working conditions of rubber production. At the same time, it is of interest and there is a practical need for a sanitary-hygienic assessment of the working conditions of workers in basic occupations who are in contact with chemical substances of a general toxic and irritant action during production. Considering that the production of rubber products is based on a multistage intermittent technological process using numerous chemicals of the second, third and fourth classes of toxicity, and during a work shift, production personnel is

subjected to fractional and short-term exposure to toxic chemicals working in the rubber industry, sanitary assessment of working conditions of workers SIC rubber-production professionals.

Methodology

To assess the working conditions of workers in the main occupations of rubber production, the following sanitary and hygienic studies were conducted: the study of air dustiness by the aspiration-weighting method with sampling filters АФА-10 electric aspirator [8, 9], gas chromatography method [10], the study of the microclimate in terms of temperature and relative humidity with an aspiration Assman psychrometer, a spherical cathetometer and a wing anemometer [11]. There were conducted a research with specialists from the National Center for Occupational Hygiene and Occupational Diseases of the Ministry of Health of the Republic of Kazakhstan.

Results and discussion.

The microclimate of the rubber products plant, depending on the season, and the specifics of the technological process, is subject to sharp fluctuations. Under the influence of unfavorable factors of production such as overcooling, overheating, significant physical stress, etc. The toxic effect of chemicals used in the rubber industry [12, 13] increases. The analysis of the microclimate at workplaces in the preparatory and conveyor-belt shops of rubber production was carried out. The analysis of microclimatic studies, studied in the cold and warm period of the year, made it possible to establish its dependence on the technological process stage, the building construction features, and also the temperature conditions of the outside air. It was established that, depending on the time of year, both the heating microclimate and the cooling microclimate are formed in the production premises. The studies were conducted at an outdoor air temperature equal to (–8.5 ± 0.9) below zero, on average. Analysis of the microclimatic conditions showed that in the cold season there is a decrease in air temperature in the preparatory workshop at the hinge section of ingredients, where the average air temperature was 5.0 ºС, air humidity was 80 %, and at the rubber mixer section the air temperature was 2.0 ºС, air humidity — 86 %, while the temperature in the conveyor-belt workshop at the workplace of the driver-roller, the air temperature was 14.0 ºС, air humidity — 73 %, the driver-calender air temperature — 15.0 ºС, humidity — 70 %, a collector of conveyor belts and a pressman-vulcanizer, the air temperature is 16 ºС, the humidity is 75 %.

During the warm period of the year, the air temperature of the production premises is allowed up to 25 ºС with relative humidity of 30–60 %. The outdoor temperature was 22.8 ºС. With a heating microclimate, the air temperature in the production premises is allowed 3 ºС higher than the outside. The average air temperature in the preparatory workshop at the hinge section was 21.0 ºС, the air humidity was 75 %, at the rubber mixer section the air temperature was 22.4 ºС, and the air humidity was 73 %. In the conveyor-belt shop, the air temperature at workplaces was 23 ºС, at a relative humidity of 80 %. It should be noted that the unfavorable microclimate of the production environment in the conveyor-belt and molded workshops of the plant is due to the technological features of the vulcanization process. Heat is supplied by a mixed radiation-convective type, since the surfaces of the molds, vulcanization rubber products are sources of infrared radiation. The temperature of the surface of the molds during extraction from the molds reaches 160–180 ºС, and the temperature of the molds during recharging is more than 100 ºС. All this creates high levels of radiation and causes an unfavorable temperature regime of production.

Thus, the unfavorable microclimate of the production environment in the main workshops is due to the large area of the premises, not isolated between themselves, both vertically and horizontally, insufficient heating system power, and also features of the technological process of vulcanization, which contribute to the formation of adverse temperature conditions at workplaces.

One of the unfavorable production factors at the factory rubber products is the dustiness of the air. The technological process of production is inevitably associated with dust and gas formation. The formation of aerosols of disintegration of complex composition in the working area is due to incomplete automation of the process, the use of manual techniques (rubbing, weighing, screening, backfilling and loading of bulk substances), the lack of local aspiration in the area of weighing and storing bulk materials. A high concentration of toxic dust of mixed composition was observed at the moment of loading the ingredients into the rubber mixer funnel manually. As a result of the research conducted, it was established that in the preparatory workshop at the workplace of a hitch weeper the dust of mixed composition is*:* thiuram — 3.3 mg/Nm^3 at maximum allowable concentration — 0.5 mg/Nm^3, sulfur — 6.9 mg/Nm^3 at maximum allowable concentration — 2.0 mg/Nm^3, carbon — 14.0 mg/Nm^3, at maximum allowable concentration — 4.0 mg/Nm^3, talc —

5.1 mg/Nm^3, at maximum allowable concentration — 4.0 mg/m^3. At workplaces of the rubber mixer, the steamer cabinet was installed an excess of phenol, which amounted to 0.38 mg/Nm^3 at the maximum permissible concentration is — 0.3 mg/Nm^3. The results of sanitary and hygienic studies have shown that the content of phenol, carbon monoxide, sulfur dioxide, vapors of hydrochloric acid, nitric oxide at workplaces do not exceed the maximum permissible concentration of harmful substances in the working area air, except for the workplace of the roller operator a tape shop, where the phenol content is 0.38 mg/Nm^3, with a normalized value 0.3 mg/Nm^3.

Conclusions

Thus, the results of the studies showed that the excess of the maximum permissible concentration was established in the preparatory workshop at the workplace of the driver-rubber mixer (excess of the maximum permissible concentration of phenol by 1.3 times), hanging weight (exceeding the maximum permissible concentration of thiuram more than 6.6, sulfur — 3.5, carbon black — 3.5, talc — 1.3). In the conveyor-belt shop the excess of the maximum permissible concentration is set at the workplace of the driver-roller (the excess of the maximum permissible concentration of phenol is more than 1.3). Consequently, a study of the working conditions of workers in the main occupations of rubber production revealed that the «multifactorial» technology and the specifics of technological processes form a complex of unfavorable factors of the working environment, of which are mixed dust (thiuram, talc, soot, sulfur, etc.), vulcanization gases (phenol), microclimate. In this connection, the risk increases not only of general morbidity, but also of pathology on the part of the respiratory organs, the gastrointestinal tract, the hepatobiliary system, etc.

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Техникалық резеңке өндірісіндегі негізгі кәсіби жұмысшылардың еңбек жағдайлары мен еңбек үрдісінің ерекшеліктерін бағалау

Әдебиеттерде техникалық резеңке өндірісінің жұмыс жағдайы мен еңбек үрдісін бағалау бойынша көптеген әртүрлі жұмыстар кезедеседі. Сонымен қатар химиялық заттармен өндіріс процесінде жалпы уытты және тітіркендіргіш әрекеттермен байланыс жасайтын негізгі кәсіптердегі жұмысшылардың еңбек жағдайларын санитарлық-гигиеналық бағалауда практикалық маңыздылығы зор және қызығушылық тудырады. Техникалық резеңке бұйымдарының өндірісі уыттылықтың екінші, үшінші және төртінші кластарындағы көптеген химиялық заттарды пайдаланатын көпсатылы үзіліссіз технологиялық үрдіске негізделген. Жұмыс ауысымында өндіріс қызметкерлері улы заттардың фракциялық және қысқамерзімді әсеріне ұшырайды, сондықтан техникалық резеңке өнеркәсібінде қолданылатын химиялық заттардың улы әсерлерінің көбеюі жұмыстың негізгі мақсаты болып табылады. Техникалық резеңке өндірісінің негізгі жұмысшыларының жұмыс үрдісін және жұмыс жағдайын бағалау үшін ауаның шаңдылығын, микроклиматты және салыстырмалы ылғалдылығын зерттеу жүргізілді. Зерттеу нәтижесінде техникалық резеңке өнімдері зауытындағы қолайсыз өндірістік факторлар болып шаң, ауаның ластануы, суып кету, қызып кету және аздаған физикалық кернеу табылады.

Кілт сөздер: техникалық резеңке өндірісі, технологиялық үрдістер, улы химикаттар, шаңның пайда болуы, газдың пайда болуы.

А.М. Рахметова, Г.К. Алшынбекова, Г.А. Тусупбекова

Особенности трудового процесса и оценка условий труда рабочих основных профессий резинотехнического производства

В литературе имеется большое количество разноплановых работ по оценке трудового процесса и условий труда резинотехнического производства. Представляет интерес и существует практическая необходимость санитарно-гигиенической оценки условий труда рабочих основных профессий, контактирующих в процессе производства с химическими веществами общетоксического и раздражающего действия. В основе производства резинотехнических изделий лежит многостадийный прерывистый технологический процесс с использованием многочисленных химических веществ второго, третьего и четвертого классов токсичности. За рабочую смену производственный персонал подвергается фракционному и кратковременному воздействию токсических веществ, следовательно, усиливается токсическое воздействие химических веществ, применяемых в резинотехнической промышленности на работающих, что и явилось целью исследования. Для оценки трудового процесса и условий труда рабочих основных профессий резинотехнического производства проводились изучение запыленности воздуха, микроклимата, относительной влажности. В результате проведенных исследований установлено, что неблагоприятными производственными факторами на заводе резинотехнических изделий являются запыленность, загазованность воздуха, переохлаждение, перегрев и значительное физическое напряжение.

Ключевые слова: резинотехническое производство, технологический процесс, токсичные химические вещества, пылеобразование, газообразование.

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