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Wastes in Automotive Maintenance Businesses, Its Effects on Employees and Precautions

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Review Article

Abstract

This study offers an exhaustive analysis of the emissions and waste produced by vehicle maintenance and repair activities, underscoring their detrimental impacts on the health and ergonomic conditions of service workers. It underscores the critical need for the implementation of straightforward yet effective measures to mitigate these adverse effects. The paper delineates a variety of strategies aimed at enhancing the well-being of maintenance personnel by minimizing their exposure to harmful substances and improving workplace ergonomics. Heightened environmental awareness has positively influenced research on waste disposal methods. Implementing environmentally friendly waste and emission disposal methods in automotive maintenance is projected to reduce costs for mechanics and operators. Furthermore, the study elaborated on the comprehensive processes undertaken in automotive maintenance facilities, detailing the journey of waste from its origin to its final disposal. Effective management of these processes provides significant environmental and economic benefits. Additionally, the study presents a series of evidence-based recommendations designed to cultivate a safer and healthier working environment for automotive service professionals. These recommendations aim to improve overall working conditions in the industry by contributing to the enhancement of occupational health and safety standards. Through these measures, the research advocates for a comprehensive approach to occupational health within the automotive repair industry.

Keywords: Automotive; Car mechanic; Environment; Health; Maintenance; Service; Waste

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1. Introduction

The motor vehicle industry is experiencing significant global growth. Motor service operations, including maintenance and repair, generate various wastes and emissions. Maximizing the recycling of solid and liquid wastes necessitates their disposal in an economically and environmentally appropriate manner. The sector bears significant responsibility for minimizing waste generated from maintenance operations at auto repair shops, ensuring their reuse or recycling. Wastes produced by the motor vehicle repair sector are more hazardous than household wastes. Thus, meticulous management of these wastes is crucial. Certain wastes commonly found in automotive repair and body shops are classified as special wastes. According to the EPA (Environmental Protection Agency) definition, special wastes include hazardous waste, pollution control waste, and industrial process waste. Waste exhibiting characteristics such as flammability, toxicity, corrosivity, or reactivity is classified as hazardous. Industrial process waste is any liquid, solid, semi-solid or gaseous waste generated while manufacturing a product or performing a service. Common vehicle wastes may include used oil, antifreeze, solvents, paints, coatings, absorbents, batteries, and tires. “Automobile Repair Shops” include vehicle repair shops, dealerships, bicycle/motorcycle repair shops, agricultural machinery repair shops, construction machinery maintenance, fuel stations, transportation companies, and tire repair shops. Auto repair shops must mitigate hazardous waste through prevention, reduction, and recycling processes. Modernization through 'Clean Work Production Methods' will reduce waste, enhance workplace health, and lower operational costs. The reduction in environmental pollution can be achieved by using protective measures taken after the main process at each stage of the process. As a broad concept, cleaner production refers to institutional and technical changes made in workplaces and processes to ensure a significant reduction in environmental pollution [1-6]. The diagram below (Figure 1) shows the processes carried out in automotive maintenance facilities from source to waste disposal.

Fig. 1. Source to waste disposal in automotive maintenance businesses

Individuals spend approximately 80-90% of their daily time in living spaces, houses, and workplaces. Air pollution in enclosed or semi-enclosed spaces primarily triggers respiratory health issues. Factors affecting air quality include heating and cooling systems, cigarette smoke, construction materials, overpopulation, furniture, cleaning activities, personal care, hobbies (such as soldering, repair, spraying), and the operation of household appliances. In inadequately ventilated workplaces, harmful substances such as carbon monoxide, carbon dioxide, sulfur dioxide, nitrogen oxides, formaldehyde, cigarette smoke, radon, asbestos, lead, volatile organic compounds, microorganisms, and allergens contribute to indoor air pollution. Depending on the activity type, indoor air pollution in workplaces can exceed levels typically found in outdoor environments. Individuals working in enclosed workplaces experience more severe health complaints, and prolonged exposure can lead to chronic conditions. Inadequate ventilation, inappropriate physical structures, and improper temperature and humidity levels exacerbate emissions and dust pollutants. Such conditions pose significant environmental hazards. In enclosed areas, poor air quality exacerbates allergic symptoms such as headaches, itchy eyes, fatigue, dry throat, nasal irritation, drowsiness, inattention, disinterest in work, and hypersensitivity or insensitivity to odours and noise. Indoor pollutants have emerged as a significant health concern. Research has established critical lower and upper limit values for health. These limit values reflect the volatility and moisture content of waste, emissions, and dust in indoor and workplace environments, based on their physical and chemical properties. Identifying risks and hazardous conditions, measuring indoor air pollution levels, and implementing precautions are essential for the health of individuals, workers, and workplaces. Workers in auto repair shops are at risk of occupational diseases due to high exposure to toxic substances such as solvents, paints, metals, rubber residues, and particulate matter [1,5,7,8]. The diagram below (Figure 2) shows the major wastes generated during automotive maintenance processes.

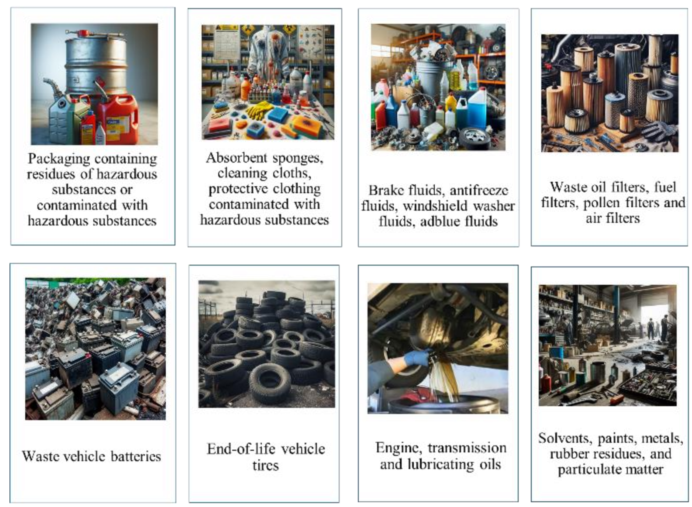

Fig. 2. The major wastes generated during automotive maintenance processes

2. Pollutants in Auto Repair Shops

Auto repair shops are significant sources of hazardous waste and environmental pollution in numerous countries. Accidental spills and leaks frequently occur during engine and vehicle component replacement, cleaning, disassembly, and fluid changes. Pollutants are released into the environment and can disperse into the air through solvent evaporation. The potential for environmental pollution exists due to waste production, accidental spills, and leakage from storage containers. Furthermore, improper auto repair practices and inadequate waste management contribute to environmental pollution in auto repair shops. Common examples of waste generated include automotive fluids and cleaning solvents. These wastes pose significant health and environmental risks if not properly collected and disposed of. Organic solvents used in auto repair for cleaning and degreasing can volatilize under ambient conditions, contributing to pollution. These organic solvents are typically highly toxic even in small quantities and are extremely resistant to environmental degradation. Chlorinated solvents, commonly used in auto repair shops for cleaning and degreasing, exemplify such pollutants.

Polluting fluids in automotive repair shops include used engine oil, transmission fluid, and brake fluid. These fluids may contain toxic heavy metals. Engine oil comprises a mixture of high-boiling hydrocarbons and organic chemicals, often in the form of hydraulic oil, which consists of heavy petroleum distillates. Heavy metals are present in various automotive fluids, typically leached from components during normal vehicle operation, such as springs, radiators, and other engine parts. Polluting liquid wastes derived from automotive activities, such as engine oil and hydraulic fluid, are heavy oil distillates. Mixed oils and glycol solutions, which constitute transmission and brake fluids, along with various heavy metals leached from engine fluids, represent significant pollutants. Antifreeze pollution in auto repair shops includes ethylene glycol, a toxic substance, and lead, which is found in filtered refrigerants. Pollution from washers in auto repair shops arises from washing cars and auto parts. Washing fluid (usually water) contains oils, detergents, heavy metals and other contaminants. Coolant pollutants in automotive repair shops primarily consist of substances used in automotive refrigerants and air conditioning systems. CFC-12 (Freon 12) was used as a vehicle coolant before 1995, but its use was banned due to its detrimental impact on the ozone layer. HFC-134, introduced after 1995, is a refrigerant gas that does not deplete the ozone layer but is known to contribute to the greenhouse effect. Paint pollution in automotive repair shops arises from paints and their derivatives, which contain commonly used organic solvents. Trichloroethylene (TCE), along with other commonly used chlorinated solvents such as carbon tetrachloride (CT), methylene chloride, and perchloroethylene (PCE or PERC), are prevalent in auto body shops. Petroleum hydrocarbons, which consist solely of carbon and hydrogen, are generally less toxic and more environmentally degradable than chlorinated solvents. Commonly utilized petroleum solvents include toluene and xylene. Other organic solvents, including methyl ethyl ketone (MEK), exhibit lower toxicity compared to chlorinated solvents. Methyl ethyl ketone (MEK) is favored as a solvent because of its high volatility and significant solubility in water. Due to its high solubility, significant environmental accumulation of MEK can result in its mixing with groundwater. This contaminant can disperse in the vicinity of repair shops, potentially causing groundwater contamination within a 1-kilometer radius. In auto repair shops, improper disposal or storage of cleaning rags can lead to environmental pollution. These wastes contain acid-water mixtures and lead (Pb) due to their composition. Battery pollution, including old, broken, or cracked car batteries, is classified as hazardous waste due to its environmental risks. These wastes contain acid-water mixture liquids and Pb(lead) due to their content. Pollutants generated during the auto repair process include spills, leaks, paint discharges, and engine cleaning fluids [8-12].

3. Wastes in Automotive Repair Shops, Definition and Prevention of Wastes

Vehicle repair and periodic maintenance generate various wastes that necessitate proper disposal. These wastes include hazardous and recyclable materials such as paint waste, cooling oil, fluids, metal dust, and shavings. Implementing precautions and recovery measures can reduce the costs associated with hazardous wastes from maintenance, service, and repair processes in auto repair shops. Waste prevention and disposal protocols are established by manufacturers and adhere to fixed change intervals. The disposal of engine oil, transmission oil, cooling fluids, and brake pad fluids is partially feasible. EU regulations aim to manage waste oils effectively, preventing environmental pollution and maximizing their recovery potential. EU regulations aim to manage waste oils effectively, preventing environmental pollution and maximizing their recovery potential. The management and disposal of waste oils and other hazardous wastes from auto repair shops are governed by Directive 2008/98/EC on waste. Although used oil exhibits hazardous waste characteristics, it is not managed as hazardous waste independently. However, if used oil is mixed with substances listed between R315-261-30 and R315-261-32 or any combination of hazardous wastes, the mixture is regulated and managed as hazardous waste. Furthermore, if used oil is combined with a 'characteristic' hazardous waste and the mixture exhibits hazardous waste properties, it is managed as hazardous waste. The Used Oil Management Standards (R315-15) presume that used oil containing more than 1,000 parts per million (ppm) of total halogens is mixed with chlorinated hazardous waste. The Used Oil Management Standards (R315-15) prevent misuse by prohibiting unsafe practices such as improper storage, road lubrication, and weed suppression [1-3,13,14]. Numerous studies have explored the implementation of proposed methods to mitigate the environmental and human health impacts of waste in automotive maintenance facilities. Examining the case studies related to these practical applications, Mehmood et al. reported that approximately 45 million tons of waste engine oil are generated annually by the automobile industry, with only 40% being properly processed and collected. To address this issue, they investigated the potential of using waste engine oils as a viable material to tackle various challenges related to environmental pollution and economic considerations. In their study on the possibility of obtaining asphalt binder material from waste engine oil, they reported that a successful asphalt binder material can be obtained by adding additives to waste engine oil [15]. In a study conducted by Zhu et al. focused on recovering ultra-fine lead oxide from spent lead-acid battery paste while minimizing environmental impact. It involved desulfurizing the paste, reacting it with citric acid to produce lead citrate, and calcining that to form ultra-fine lead oxide. Desulfurization achieved over 99% using sodium carbonate or bicarbonate, and the paste was acidified with CO_2 to create lead carbonate. The lead citrate precursor was obtained from leaching with citric acid and hydrogen peroxide, yielding lead oxide with particle sizes of 100 to 500 nm at 370 °C. This method is efficient, safe, and a promising alternative to traditional lead recovery methods [16]. Li et al. [ZZ]conducted a study on the comprehensive recycling of slag obtained from the melting of used automotive catalysts. Used automotive catalysts are classified as hazardous waste due to their high concentrations of heavy metals and organic pollutants.

The study reported that heavy metals in this catalyst can be significantly recovered by subjecting it to various chemical and physical processes [17]. Figure 3 provides examples of hazardous waste found in an automotive repair shop. Figure 4 shows a warning poster stating that it is prohibited to discharge prohibited wastes from disposal wells into shallow groundwater in motor vehicle repair shops.

Fig. 3. The major wastes generated during automotive maintenance processes

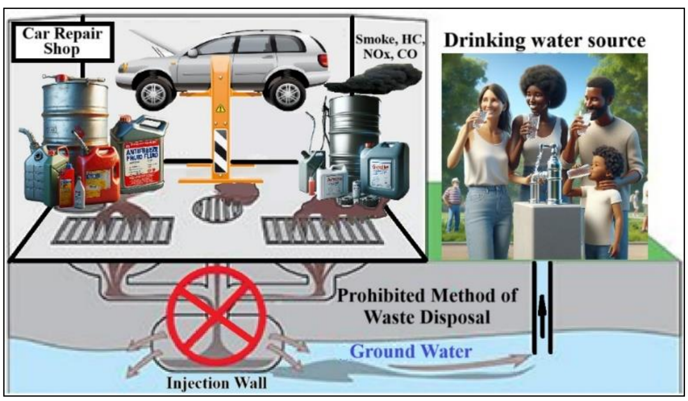

Fig. 4. Motor vehicle waste disposal wells discharge to shallow ground water

4. Air Pollution in Vehicle Repair Shops

The utilization of fossil fuels in motor vehicles offers significant advantages over other energy sources. The adverse effects of fossil fuel emissions on human health, the environment, and biodiversity are escalating globally, influenced by emission concentrations and various forms of environmental pollution. Maintenance operations in auto repair shops generate waste, including fuel-based gases, liquids, and solid by-products. As a result, employees and customers in repair shops are exposed to hazardous air pollutants (HAPs), particulate matter (PM), and volatile organic compound (VOC) emissions. Vehicle repairs and engine adjustments release exhaust gases containing benign compounds such as nitrogen, oxygen, carbon dioxide, and water vapor. However, these processes also generate harmful substances, including carbon monoxide, hydrocarbons, nitrogen oxides, lead compounds, sulfur dioxide, and particulate matter. Inhalation of gases such as CO, SO_2, and NO_x results in acid formation in the oral cavity, trachea, and bronchi, aggravating respiratory conditions such as poisoning, bronchitis, asthma, and emphysema. These harmful gases can exacerbate conditions in vulnerable individuals and, depending on exposure concentration and duration, may be fatal. It is crucial to encourage auto repair shop operators and employees to engage in activities that reduce polluted emissions. This benefits both workers and society [6-8,18].

During various maintenance operations in auto repair shops, waste and especially fuel-based exhaust emissions occur and these emissions are released into the ambient air in workplaces that do not comply with the standards. The fuel-air ratio significantly influences the formation of the three primary pollutants: CO, HC, and NO_x. Approximately 15-16 kg of air is required to achieve complete combustion of 1 kg of fuel. The effects of primary air pollutant emissions on the human body, depending on their concentration, exposure duration, and other characteristics, are summarized below. **Carbon monoxide (CO)** is a pollutant resulting from the incomplete combustion of carbon-based fuels, where insufficient oxygen prevents full oxidation. CO is a colorless, odorless, and tasteless gas, commonly produced when gasoline engines idle. It is toxic to living organisms and can be lethal at concentrations of 0.3% in air. Global annual CO emissions average approximately 232 million tons. CO persists in the atmosphere for over two months, significantly affecting air quality. Approximately 70% of CO emissions originate from the transportation sector, and it is estimated that atmospheric CO levels will increase by 0.03 ppm annually due to its accumulation in the lower layer atmosphere. CO reduces the oxygen-carrying capacity of blood, leading to functional impairments in blood vessels, organs, and tissues, including the brain, heart, kidneys, and lungs. CO present in urban air significantly impacts human health, primarily by reducing the oxygen-carrying capacity of hemoglobin in the blood. **Nitrogen oxides (NO_x)**; nitrogen is the main component of air and does not react with oxygen at normal temperatures. Nitrogen oxides are generated through combustion processes in motor vehicles and energy production facilities. As a result of the high energy released in combustion processes that occur at high pressure and temperature in engines, it enters a chemical reaction with oxygen and forms nitrogen oxide. NO and NO_2 compounds are defined as NO_x. High levels of NO_x concentrations irritate the respiratory system and show signs of poisoning. Excessive exposure to brown and odorous N_2 can lead to fatal lung diseases and paralysis. The nitrogen oxides significant for air pollution include nitrogen monoxide (NO) and nitrogen dioxide (NO_2). Their persistence in the atmosphere is approximately 24 hours. Corrosive effect on materials is toxic in terms of human health. When nitrogen is oxidized and turns into nitrogen oxide, it becomes a pungent, yellow-brown colored and harmful emission. **Hydrocarbons (HC)** are compounds consisting of hydrogen and carbon. Hydrocarbons are produced during the combustion processes of petroleum product fuels, during filling and storage processes or by industrial solvents. When combustion cannot be completed due to insufficient air during the combustion process, CO is formed and as a result, unburned or partially burned HC emissions occur. It is also formed by the evaporation of gasoline in the tank or during filling. Hydrocarbons form ozone (NO_3) with the effect of NO and sunlight. High levels of unburned HC concentrations are harmful to health and are also stated to play an important role in the destruction of forests. Unsaturated hydrocarbons and aromatics play an important role in the formation of smog (Smoke+Fog). Methane constitutes the largest percentage of hydrocarbons with varying persistence times in the atmosphere and its lifespan is estimated to be 0.94 years. It is known that ethylene stops plant growth, unburned hydrocarbons such as liquid-solid (tar, pitch) have carcinogenic effects and aromatic hydrocarbons are carcinogenic substances. **Sulfur oxides** (SO_x); the most common air pollutant emissions and especially as a result of burning solid fossil fuels (coal), SO_2 is released into the atmosphere. The majority of sulfur oxides are produced from the combustion of fossil fuels in stationary sources. Fossil fuels such as oil and coal contain sulfur in concentrations ranging from 0.5% to 6%, whereas gasoline typically contains about 0.1% sulfur. Sulfur dioxide is formed due to the oxidation of sulfur in the fuel. Sulfur dioxide (SO_2) emissions are highly effective, non-flammable, colorless gases that cause nasal irritation. Its effect is strengthened by the particles in the exhaust gas, causing damage to the respiratory tract and burning in the eyes. SO_2 has a detrimental impact on the environment, particularly affecting green leafy plants. The combination of sulfur dioxide and fine particulate matter, which can penetrate the lungs, along with toxic heavy metals, poses significant health risks to humans. Approximately 95% of high concentrations of sulfur dioxide are absorbed through the upper respiratory tract, leading to bronchitis, emphysema, and other pulmonary diseases. Due to their oxidizing properties, these substances impact the human respiratory tract even at low concentrations, reducing resistance to infections. Human activities are responsible for a significant proportion of sulfur oxide emissions. These emissions have a 24-hour half-life and persist in the atmosphere for about 40 days. High concentrations of sulfur dioxide and dust can cause air layers to become dense, hindering air movement and leading to adverse conditions. Global SO_2 concentrations are known to increase by 0.006 ppm annually, and all acids and sulfates are removed from the atmosphere through precipitation within approximately 43 days. **Lead compounds**, utilized to prevent knocking in gasoline engines, are emitted into the atmosphere through exhaust gases. Lead compounds in the fuel work as a kind of lubricant in the intake and exhaust valves and reduce wear at these points. Lead compounds cause diseases in blood cells, nerve cells and bone marrow. Reducing the amount of lead in gasoline is important both for the environment and for the performance and lifespan of catalysts. Lead exposure can cause vision and movement disorders in living organisms and can be fatal to animals. Plants are more sensitive to these environmental poisons than humans. Therefore, emission values should be minimized as much as possible, even if complete elimination at the source is not feasible. Animals useful in agriculture are particularly damaged by fluoride and lead. Fluoride induces fluorosis in calves, alters bone structure, and leads to movement disorders, loss of appetite, and weakness [6-8, 18-20]. Individuals employed in auto repair shops are exposed to vehicle exhaust emissions, fuel vapors, and the effects of paints, solvents, and chemicals. They are also at risk of health issues, including injuries and disabilities, due to physical hazards encountered while working with heavy equipment and machinery.

5. Air Pollution Prevention Methods in Vehicle Repair Shops

Under standard conditions (in an office-workplace environment), air containing carbon dioxide levels not exceeding 0.1% is considered clean air. In auto repair shops, which are evaluated in the industrial type of business line, when it comes to clean air, volatile substances such as gas and dust are important along with carbon dioxide. Workplace ventilation is defined as the improvement of air quality. It ensures that parameters critical for thermal comfort, such as temperature, humidity, air flow speed, and thermal radiation, do not cause discomfort to individuals. Additionally, it encompasses the body's thermal regulation, involving the exchange of heat between the body and its environment. Comfort, defined as feeling comfortable in the environment where a person is, includes different values for summer and winter. These values are defined as 22-24 °C temperature, 35-40% relative humidity for winter conditions and 24-26 °C temperature, 50-55% relative humidity for summer conditions. Indoor climate comfort determines the level of comfort in terms of heat or other climatic conditions. Thermal comfort, on the other hand, defines the upper and lower limits of thermal conditions necessary for an employee to perform their activities comfortably. Factors influencing thermal comfort include heat dissipation, air flow, humidity, air temperature, work clothing, and employee activity levels. Manufacturers must provide appropriate temperature, comfort or design conditions for production, production control and different work environments. For human comfort, these conditions should be kept between 18-27 °C for temperature and 30-60% for employee comfort. Increased ventilation is necessary during the summer months, while reduced air movement is required for the filtration and comfort concerning particulate matter (PM) and harmful gases (SO_2, CO_2, etc.) in the workplace air. Deterioration of body temperature regulation and increase to 41°C can cause heat stroke, low blood pressure, dizziness, itching, skin disorders, low morale, lack of concentration, hypersensitivity, and anxiety. According to research, when the temperature rises to 29 °C, performance decreases by 5%, at 30 °C by 10%, at 31 °C by 17% and at 32 °C by 30%. It is stated that there is a significant increase in the number of work accidents as the ambient temperature in the workplace moves away from 19.8 °C. It is accepted that an adult needs 30 m3 of fresh air per hour and that the air in the environment changes 2-3 times per hour with natural ventilation under normal conditions. The air volume per person in workplaces is defined as 10 m^3 and the ceiling height is defined as 4 meters in the calculation of air volume. Under normal conditions, the ceiling height of the workplace should be at least 3 meters, and the ceiling height should be at least 3.5 meters in environments where harmful dust and gases are present. Workplaces should provide at least 2.52 square meters of free space per person. Jobs done sitting require 12 m^3, standing jobs need 15 m^3, and heavy physical work requires 18 m^3 per employee [2,5,7,11,14]. A ventilation diagram for a vehicle service is given in Figure 5.

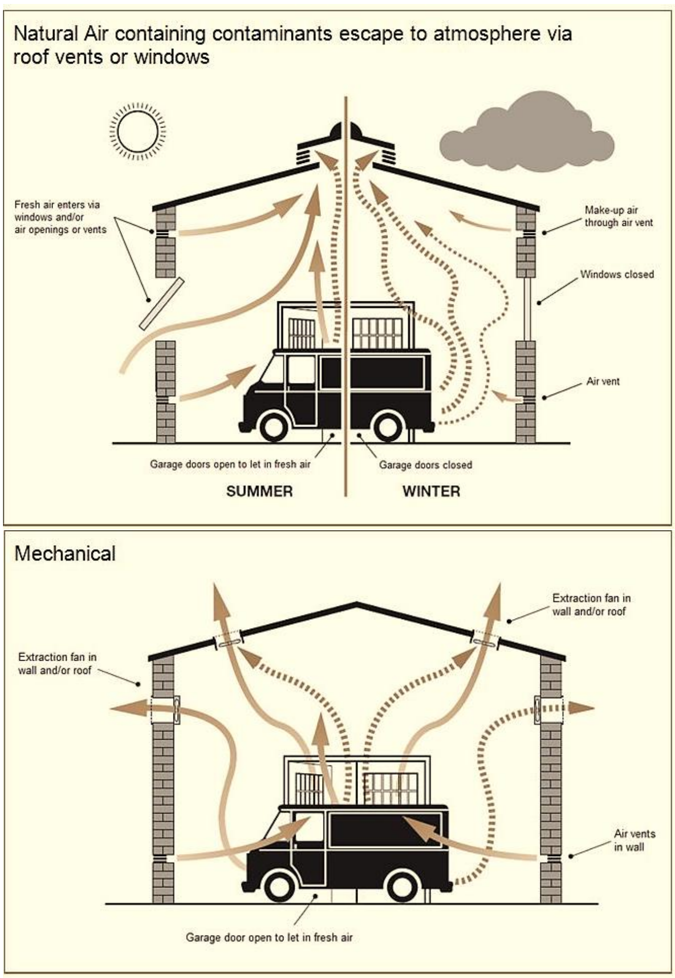

Fig. 5. Motor vehicle waste disposal wells discharge to shallow ground water

6. Conclusion And Recommendations

New approaches to waste in the automotive industry, the environmental effects of wastes resulting from maintenance and service processes are supported by new incentives and laws in many countries of the world. As a result of these supports; increased awareness about the environment has contributed to awareness and measures regarding the disposal of produced wastes. It is mandatory to comply with the regulations requested for the environment in the re-evaluation and disposal of such waste products. The three basic principles of waste management; producing less waste, recycling wastes and disposing of wastes without harming the environment are required. In the auto repair sector, which is one of the risky lines of business, the rate of protective equipment use by mechanics in their repair shop work is low. In this sector, a large amount of various wastes are produced during maintenance operations after sales. Especially in the winter months when air pollution is intense, repairmen working indoors are more exposed to fossil fuel waste and emissions. Auto repairmen are also at risk due to the density of pollutants in the indoor air of the workplace and the length of the working hours. It is predicted that respiratory diseases will increase as they are exposed to more air pollutant emissions with long-term work in a closed environment. On the other hand, air pollution in the workplace environment increases even more with the burning of fossil fuels for heating purposes in workplaces in the winter months. Repair shop workers are exposed to intense exhaust gases such as carbon monoxide, hydrocarbons and nitrogen oxide, as well as harmless substances such as water vapor, carbon dioxide and nitrogen dioxide in engine exhaust gases that are dangerous for humans and the environment. The use of tobacco products and diseases related to them are increasing especially in developing countries. In these countries, smoking is generally high among employees working in the sector and the age at which young employees begin smoking is also quite low. As a result, mechanics are at risk of respiratory diseases because they work in a business focused on emissions and waste. While workplace air quality is important for the long-term protection of employees' lung health, it is important to provide awareness training on this issue. Preventive procedures that should be carried out in Vehicle Repair Shops are given below.

-The evaluation and recovery of waste oils involve obtaining energy through the combustion of these oils after undergoing filtering, purification, and refining processes to produce regenerated base oil. This method also aims to prevent environmental pollution by ensuring the oils are burned using appropriate combustion systems.

-In workplaces that perform vehicle maintenance, water and other washing product wastes are discharged into the city sewerage as dirty water without being purified. It is possible to have a cleaner environment with less wastewater production by fulfilling the authorities and responsibilities of the relevant local institutions in this regard.

- Batteries contain toxic wastes like sulfuric acid and lead. Awareness training on their environmental impacts should be provided to sector employees and users, with cooperation from professional chambers and local governments.

-Impermeable materials should be used in the collection of lubricant oil and other chemical leaks.

-Ambient air should be clean, changed regularly and compressed air should be avoided to prevent excessive dust.

- Emission transport systems should be used in engine and vehicle exhaust emission maintenance processes.

- Emission adjustments should be made using pollution control devices to reduce exhaust gas pollution.

-Engine adjustments should not be made in public places due to noise, and vehicle exhaust gas should not be allowed to be discharged uncontrolledly.

- Emission devices that comply with vehicle exhaust gas standards should be used to reduce emissions emitted by vehicles in engine exhaust emission tests.

-Supportive training should be provided to employees to prevent accidents and injuries.

-Tools and equipment should be protected and checked before each use.

-Workers should be encouraged to report unsafe conditions and actions, personal protective equipment should be used, and training support should be provided for prevention.

-Workplace ventilation equipment should exhaust, chemical vapors and dust from the work area and fresh air should be provided.

-The impact of pollutants on the environment, businesses and employee health should be reduced by using environmentally friendly products.

Conflict of Interest Statement

There is no conflict of interest among the authors.

CRediT Author Statement

Murat Çetin: Conceptualization, Writing-original draft, Validation,
Oğuz Kürşat Demirci: Conceptualization, Writing-original draft, Validation, Supervision, Formal analysis, Visualization, Writing - review & editing.

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