

Course Learning Outcomes for Unit VIII

Upon completion of this unit, students should be able to:

1. Assess engineering principles applicable to solid and hazardous waste management.
2. Examine key attributes of solid and hazardous wastes.
5. Evaluate technologies related to the minimization of industrial and hazardous wastes.
6. Assess the impact of industrial and hazardous waste on human populations.
 - 6.1 Explore health effects on humans concerning industrial and hazardous waste.
7. Formulate strategies for solving industrial waste related problems.

Course/Unit Learning Outcomes	Learning Activity
1, 2, 7	Unit Lesson Unit VIII Course Project
5	Unit Lesson Article: "Assessment of Hydrothermally Modified Fly Ash for the Treatment of Methylene Blue Dye in the Textile Industry Wastewater" Unit VIII Course Project
6.1	Unit Lesson Unit VIII Course Project

Required Unit Resources

In order to access the following resource, click the link below.

Mor, S., Chhavi, M. K., Sushil, K. K., & Ravindra, K. (2018). [Assessment of hydrothermally modified fly ash for the treatment of methylene blue dye in the textile industry wastewater](https://libraryresources.columbiasouthern.edu/login?url=http://search.ebscohost.com/login.aspx?direct=true&db=bsu&AN=128506516&site=ehost-live&scope=site). *Environment, Development & Sustainability*, 20(2), 625–639. Retrieved from <https://libraryresources.columbiasouthern.edu/login?url=http://search.ebscohost.com/login.aspx?direct=true&db=bsu&AN=128506516&site=ehost-live&scope=site>

Unit Lesson

Introduction

Congratulations on proceeding to the last unit of the course. Unit VIII summarizes the course with applications; it will show applications of the course for people who work with industrial and hazardous waste. The lesson will present knowledge expectations for staff at various levels of responsibility as well as consultants. It will begin with expectations of all staff followed by additional requirements for entry-level staff, upper-level staff, engineers, and consultants, followed by managers and owners. Though organizations differ in knowledge requirements, the discussion is a general overview of expectations and the material learned in this course.

All Staff and Consultants

All levels of staff and consultants need to be familiar with the impact of industrial and hazardous waste on human populations. As discussed in Brauer (2016), it is important to recognize that substances that are generally considered harmful to human health may not be harmful at low concentrations, substances that are usually not thought of as harmful can be harmful in some situations, and substances that are not harmful by themselves may be harmful when exposed to other substances.

Industrial waste can impact human populations through various pathways. Plants that grow around toxic waste disposal areas that are poorly contained can absorb toxic chemicals into their root systems. Toxic gases could be absorbed by plants as well. Plants that take up toxic chemicals and survive could be consumed by animals or even unknowingly harvested and sold as human food. Animals that are exposed to toxic chemicals could also be consumed by humans. Direct pathways are those in which humans are directly exposed to toxic chemicals. Toxic chemicals could have acute or chronic impacts on people. Acute impacts include an immediate onset of symptoms such as coughing, difficulty breathing, eye irritation, nausea, and inability to concentrate. Chronic impacts take longer to appear. Cancer is an example of a chronic disease. It can take years to develop cancer after exposure to a carcinogen (Brauer, 2016).

Entry-Level Staff

In addition to being aware of the impact of industrial waste on human populations, entry-level staff working in environmental departments at industrial and hazardous waste facilities typically have—or soon gain—knowledge of the key attributes of solid and hazardous waste.

Solid waste is a broad category of materials to be disposed of, and it is governed by regulations under the Resource Conservation and Recovery Act (RCRA). A solid waste can be in solid form but could also be a semi-solid or a contained gas (United States Environmental Protection Agency [EPA], 2016). If a material is a solid waste, it could be considered a hazardous waste. In fact, a hazardous waste has to first be a solid waste. If it is hazardous, then many more rules apply regarding what to do with it. Thus, it is important to be able to determine if a solid waste is hazardous.

To check if the solid waste is hazardous, the first task is to determine if the waste is excluded from the definition of solid or hazardous waste. Oddly, a waste that falls under the broad definition of solid waste can be on the list of excluded solid wastes. Such wastes are not allowed to be disposed of in a solid waste landfill, and they would not be considered hazardous waste either (since a hazardous waste has to be a solid waste). An example would be domestic wastewater. While domestic wastewater falls under the broad category of solid waste (recall that a waste can be semi-solid), it is excluded from classification as a solid waste per the EPA (2016). The reason that domestic wastewater is not classified as a solid waste is that it falls under the Clean Water Act rather than RCRA, and it is treated at a central wastewater treatment plant or by an on-site wastewater treatment system.

If a solid waste is not on the exclusion list of solid and hazardous wastes, further checks need to occur to see if it is a hazardous waste. The next check is to see if it is listed on the F, K, P, or U lists (Electronic Code of Federal Regulations [e-CFR], n.d.). If so, it is a hazardous waste. If it is not on the list, then the next check is to see if the solid waste shows the characteristics of a hazardous waste. The characteristics are toxicity, reactivity, ignitability, and corrosivity (TRIC). There are specific tests for these characteristics (e-CFR, n.d.). If the waste does not exhibit any of the TRIC characteristics, then it is not a hazardous waste. However, if the waste does exhibit a characteristic, then there is one last check to see if it is hazardous or not.

If the solid waste exhibits the characteristics of a hazardous waste based on its toxicity, reactivity, ignitability, or corrosivity, then the last check to see if a solid waste is considered hazardous is to check to see if the waste has been de-listed from hazardous waste classification (e-CFR, n.d.). If the waste has been de-listed, it is not considered a hazardous waste. If you do not find the waste on this list, then the waste is considered hazardous, and RCRA hazardous waste regulations must be followed for its treatment, storage, or disposal.

Upper-Level Staff, Engineers, and Consultants

In addition to understanding the impact of industrial and hazardous waste on human population and the key attributes of classification of solid and hazardous waste, upper-level staff, engineers, and consultants in the industrial waste field are expected to have an understanding of treatment technologies and, depending on their role, engineering principles. There are many technologies used for treating industrial wastes. Treatment methods fall under the broad categories of physical, chemical, physicochemical, biological, stabilization, and thermal technologies.

The most common physical treatment methods are sedimentation (putting the waste liquid in a tank and letting the solids settle out), oil skimming, and filtration. Chemical treatment technologies utilize the addition of chemicals to a waste stream in order to induce chemical reactions. One of the most common chemical treatment methods is to add a chemical to raise the pH (hydrogen potential) to cause precipitation. The precipitate is a suspended solid that can then be removed by filtration or sedimentation.

A common physicochemical process is carbon adsorption. A liquid or gas is passed through a bed of activated carbon. The many small pore spaces in the carbon trap the chemicals, thus removing them from the liquid or gas stream. Another common physicochemical treatment technology is air stripping. In air stripping, a liquid waste stream contacts a clean air stream flowing opposite in direction to each other in a vertical chamber. Upon contact, the volatile contaminants in the liquid waste stream become swept up in the gas stream, rendering the liquid stream effluent cleaner than its influent stream.

Biological treatment utilizes bacteria to catalyze chemical reactions, which means to encourage the reaction to proceed. Stabilization encapsulates a hazardous waste so that it does not migrate or degrade into a more toxic form. Lastly, thermal treatment typically occurs at very high temperatures to chemically convert hazardous waste to a less hazardous form. An incinerator is an example of thermal treatment.

Another role for upper-level staff, engineers, and consultants is to take the results of other investigations, such as research by universities and apply the principles to modify existing treatment methods or to create new ones. Engineering principles of mass, momentum, and energy conservation can be used to scale-up pilot tests to larger-scale treatment operations.

Managers and Owners

Owners including boards of directors, chief executive officers, presidents, or partners—depending on the type of corporation—are responsible for formulating the strategy of the company. Managers, while oftentimes contributing to strategy, are typically responsible for making decisions about hiring, directing staff, major equipment purchases, and process treatment guidelines.

Owners and managers set the tone of the company. These individuals are the ones who are most likely to decide where on the spectrum the corporation will be with regards to being reactive or proactive with industrial waste management. A reactive company waits until regulations or fines become so burdensome that it institutes new waste management technologies or process changes to comply with regulators. A proactive company is always on the lookout for how to save money and improve its environmental footprint. Such a company will even look further to the future by implementing pollution prevention options without total knowledge of the future cost implications with the expectation that being a good environmental steward pays dividends in other ways, such as good publicity.

Conclusion

This lesson has provided an application of the course for people in the industrial waste discipline at various stages of their career. From entry-level staff to upper-level staff (and engineers and consultants) to managers and owners, the knowledge areas have been presented. Everyone in the field is expected to have knowledge of health impacts of industrial and hazardous waste. Entry-level staff should understand the key attributes of these wastes. Upper-level staff, engineers, and consultants would be expected to have knowledge of treatment technologies and, for some, engineering principles. Finally, managers and owners formulate strategy for the company.

We hope that you have enjoyed the course and are able to apply the information learned to your career in industrial and hazardous waste management.

References

Brauer, R. L. (2016). *Safety and health for engineers* (3rd ed.). Hoboken, NJ: Wiley & Sons.

Electronic Code of Federal Regulations. (n.d.). Title 40: Protection of the Environment, Part 261— Identification and listing of hazardous waste. Retrieved from <https://www.ecfr.gov/cgi-bin/text-idx?SID=43a12e65fc62ad2c4af072873b86c581&mc=true&node=pt40.26.261&rgn=div5#se40.26.261>

United States Environmental Protection Agency. (2016). Criteria for the definition of solid waste and solid and hazardous waste exclusions. Retrieved from <https://www.epa.gov/hw/criteria-definition-solid-waste-and-solid-and-hazardous-waste-exclusions>

Suggested Unit Resources

In order to access the following resource, click the link below.

The following website of the Electronic Code of Federal Regulations details the regulations for identification and listing of hazardous waste.

Electronic Code of Federal Regulations. (n.d.). [Title 40: Protection of the Environment, Part 261](https://www.ecfr.gov/cgi-bin/text-idx?SID=43a12e65fc62ad2c4af072873b86c581&mc=true&node=pt40.26.261&rgn=div5#se40.26.261)— Identification and listing of hazardous waste. Retrieved from <https://www.ecfr.gov/cgi-bin/text-idx?SID=43a12e65fc62ad2c4af072873b86c581&mc=true&node=pt40.26.261&rgn=div5#se40.26.261>