**ENGR 202/2 – Sections Hand G**

**Fall 2022**

**ASSIGNMENT #1**

( Due date : Section H : September 28, 2022)

( Due date: Section G : September 29, 2022)

**1. Question 1.5 (Rubin's book)**

**How do the concepts of green design, industrial ecology, and sustainable development differ from past approaches to engineering design?**

**Prepare a brief report on this topic, using some specific examples for illustration.**

With the introduction of green design, industrial ecology and sustainable development, employees and companies that were accustomed to deprecated engineering practices that polluted the planet had to quickly adapt to new regulations adopting these healthier practices. Past approaches to engineering designs involved very little care to our environment as capital profit was the primary goal, and as such, this methodology is no longer sustainable the dangers behind the environmental impacts of such practices have been demonstrated countless times. Examples of such include single-use disposable products such as alkaline batteries from old CD players or large products that environmentally difficult for disposal such as an old car that ran out of use (Davidson & Rubin, p. 9). These products were designed with the intent of being thrown away once their lifecycle runs out, thus creating a lot of waste. The real danger, however, is that there is absolutely zero care of their environmental impact once disposed of. There are methods to circumvent these environmental dangers; one of them being careful selection of materials. Instead of choosing the cheapest and most available material, we must judge how that material might affect the environment once used in production (Davidson & Rubin, p. 10) and if not, look for alternatives. Another method is the manufacturing processes behind finished products. Each stage of the product’s manufacturing process will release waste to the environment through “air pollutants, water pollutants and solid wastes” (Davidson & Rubin, p. 10). This is further emphasized by the engineering college curriculum as students are not introduced to manufacturing methodologies, thus putting less of an emphasis on the environmental impacts from these processes (Davidson & Rubin, p. 10). Our jobs as engineers are to continuously innovate technology so that we minimize these toxins as much as possible. While the recycling of materials remains important, the conservation of energy is equally as important. Heating, gasoline, and electricity are all examples of energy and thus, we must consume these resources efficiently. More polluting energies such as fossil fuels must be soon replaced by an alternative. Ideally, we must incorporate all these changes to any product’s lifecycle so that we can reduce environmental impact to a minimum. Luckily, progress has been made as in Germany, IBM were obliged to dispose all their discarded computers safely and environmentally, thus causing them to rework the production line. As a result, this led to a “substantial reduction in environmental impacts throughout the product life cycle, without compromising the product’s performance or adding to its cost” (Davidson & Rubin, p. 9). We, as the future engineers that will lead society, must begin developing products in a manner that will create a more ecological and sustainable environment when our planet is on the verge of environmental collapse.

**2. Using the Canadian National Pollutant Release Inventory (through the Environment Canada Website ), choose any 3 chemicals and determine their quantities released to the air, water and land.**

We are going to choose three chemicals based on the Canadian National Pollutant Release Inventory (National Pollutant Release Inventory): Ammonia, Arsenic and Mercury.

1. Ammonia (NH3 & NH4):

Ammonia is a colorless gas which makes it hard to notice with the naked eye, but it does come with a pungent odor. It has been commonly released into the air, water and land causing long-term health diseases to anyone that comes in contact in large quantities.

In 2019, NPRI recorded that over 69,400 tonnes of ammonia have been released into the air, water and land with water being the main media type. According to their graph, about 50,423 tonnes of ammonia has been released into water streams, air with about 18,571 tonnes released and finally, land only has a mere 398 tonnes released (National Pollutant Release Inventory: ammonia).

1. Arsenic:

Arsenic is a “tasteless and odourless natural element widely found in the earth’s crust” and is often divided into two categories: organic arsenic and inorganic arsenic. In our case, inorganic arsenic is the main element behind the nefarious effects on the environment and health. (The National Pollutants Release Inventory: arsenic, 2022)

As dangerous as the chemical might be, there has been a declining trend over the release of arsenic into the water, air, and land. According to the NRPI, there has been a total release of 47.8 tonnes of arsenic into the air, water, and land in 2020. Air is the leading media with the most amount of arsenic at 26.2 tonnes with land following suit at 12.6 tonnes and finally, water at 9 tonnes. (The National Pollutants Release Inventory: arsenic, 2022)

1. Mercury (Hg):

Mercury is a heavy metal found primarily in the form of a liquid or mineral and can be found in various natural substances. Once released into the air, water, and air, it can pose a serious threat to living organisms as it can be dangerously toxic even in low doses (National Pollutant Release Inventory: mercury, 2022).

In 2019, it has been reported that facilities have released about 1,950 kg of mercury. 95% of releases were sent into the air while water releases only represented 5% of all releases. Very little mercury has been released to the land (National Pollutant Release Inventory: mercury, 2022).

**3. Question 2.11 ( Rubin's book)**

**Investigate the estimated resource base of world energy supplies of either crude oil or natural gas (choose one). One useful website is the Energy Information Administration of the U.S. Department of Energy (www.eia.doe.gov). Comment on when or whether we might be "running out of this non-renewable resource based on current estimates. Also discuss whether the environmental implications of future energy resource extraction might change because of the location or difficulty of exploiting the remaining reserves. Summarize your findings in a brief report.**

Natural gas is a natural source of energy formed due to the different compounds beneath the earth’s surface. As such, we use it extensively to fuel everyday appliances and to create materials. Because it is formed from the remains of living organisms of million of years ago, we have an abundant of natural gas that we can harvest from the Earth, but as society’s needs and demands have raised, the use of natural gases have further increased causing more chemicals such as methane (CH4) to be released into the atmosphere. (Natural gas explained, 2021). While natural gas is a relatively cleaner fossil fuel compared to crude oil, its methane emissions are still noteworthy due to natural gas leaks and in 2019, 29% of all methane emissions in the United States were from “natural gas, petroleum systems and from abandoned oil and natural gas wells.” (Natural gas and the environment, 2021). As for the natural gas reserves, it is continuing a slowly and steady decline since 1980 except for a few cases where it resurged due to new excavation techniques or due to a favorable economic situation. In fact, since the end of 2019, there has been a decrease of 4% of natural gas reserves, a setback to 2018’s results. We are slowly running out of proved reserves and wells of natural gas that we can use to extract. There are several locations in the United States that are classified as TRR meaning Technically Recoverable Resources. These locations are favorable places to extract natural gas due to their geologic nature however none of it can be extracted because of various economic and technological factors. “EIA estimates in the Annual Energy Outlook 2021 that as of January 1, 2019, the United States had about 2,867 trillion cubic feet (Tcf) of TRR of dry natural gas.” (How much natural gas is left, 2022). As supply decreases, the average price for natural gas increases, thus inciting consumers to branch off to a different energy source such as renewable energy. This is amazing for the environment as a lower usage of natural gas leads to a declining release of methane into the atmosphere, thus cutting off on greenhouse emissions.

**4. Question 12.15 ( Rubin's book)**

**Use the 20-year Global Warming Potential (GWP) values in Table 12.9 to calculate an equivalent CO2, emission rate for worldwide greenhouse gas emissions as given in Table 12.1. Assume that total CFCs are divided equally among the three compounds listed. What is the percentage contribution of actual CO2, emissions to the total equivalent CO2,? What is the next most important greenhouse gas emission based on this analysis? How do these results compare to those using the 100-year GWP in Example 12.17**

In Table 12.9, we can see that CO2 remains in the atmosphere for anywhere between 50-200 years and during its lifespan, the chemical’s global warming potential remains at 1 no matter whether it is 20 years or 500 years later. Based on the figures of Table 12.1, the annual emissions for CO2 on Earth are 29,800 Mt per year. As such, we can conclude that in any year-span, the equivalent amount of CO2 is about 29,800 Mt/yr as . Compared to the rest of annual emissions from the other greenhouse gases, we can see that CO2 triumphs above all the other greenhouse gases. In Table 12.9, we can also see the emissions of other gases in equivalence to CO2. If we assume the total CFCs are divided equally amongst the other three compounds, we can see that by adding up the rest of chemicals with carbon in their nomenclature such as CH4 and CFC-11, we can see the equivalent of CO2 is about 12,240 Mt/yr. Divide this result by the equivalent of CO2 emitted per year which we found earlier, and you can see that these greenhouse gases are responsible for about 41% of actual CO2 emissions. If we compare the ratio of the amount of CO2 emitted with the total of greenhouse gases, we will see that CO2 is responsible for about 68% of all greenhouse gases. What if let’s say one day we can get rid of all CO2 emissions in the world? The fight against greenhouse gases is not over as other chemicals such as CH4 pose a huge threat. In fact, in a 100-year span, CH4 has the equivalent of CO2 of about 7,875 Mt/yr, thus we must not only find solutions against CO2 but also CH4 too.

# References

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