Carbon nanotubes and the environment: a threat or a savior

Technology

Carbon nanotubes (CNTs) are long, cylindrical strands of pure carbon molecules. Some of the characteristics that make CNTs so special is the fact that they are stronger than steel but is only 1/6th the weight, approximately 0. 43nm in diameter and conduct electricity better than copper (Smalley, 1999, as cited in Lam et al, 2008). Because of this, carbon nanotubes have been considered to be put into a variety of applications, ranging from bicycle helmets, tennis rackets to antennas for radios and solar cells. However, these carbon nanotubes sound way too good to be true, and in an article written by Jorn van Dooren (2011), he made the following claim: “ Carbon nanotubes have unexpected negative impact on the environment. ” CNTs have always been a controversial but interesting topic ever since it was discovered in 1991 (Kauffman, Star 2008). From a number of peer reviewed articles, I interpreted that CNTs does cause harm to the environment, but at the same time they also contribute to the removal of harmful substances.

Thus, in this essay I am going to validate Dooren’s claim by looking at both the good and bad sides regarding carbon nanotubes to decide if he is completely right or if there are still exceptions to his statement. CNTs are extremely light particles which could easily spread into the air and access the human body via inhalation (Lam et al, 20008). According to an article by Kolosnjaj-Tabi et al (2017), it is reported that heavy duty American engines, European cars and even Indian auto-rickshaws emit carbon nanotubes from their exhausts. It turns out, CNTs are the main components that make up PM2. 5, a particulate matter that is responsible for the most detrimental effects of air pollution (Kolosnjaji-Tabi et al, 2017). The authors also suggested that these carbonaceous particles are created when fuel is burned

inside an engine of a vehicle, and the emission intensifies especially when it’s diesel-fueled and unfortunately, production of diesel passenger cars continue to increase, and they represent more than 50% of sold vehicles. Therefore, the amount of CNTs released into the environment would predictably increase over time. To test the toxicity of this substance, an experiment was conducted on rats by Lam et al. in 2004, as cited in Lam et al. 2008.

The study involved three CNT products which had different levels of residual metals in them. The most common way of manufacturing CNTs is through the vaporization process of two catalysts which are carbon such as methane, ethylene or other hydrocarbons; and metals such as iron, nickel, cobalt and molybdenum (Lam et al, 2008). However, since there are different methods of making CNTs, the purity of the product can vary, and this affects the way living organisms’ bodies react to the exposure of this product. In particular, the study by Lam et al in 2004 suggested that, the mice that were treated with unprocessed CNTs were severely affected by granulomas; the mice treated with synthesized CNTs also showed signs of granulomas but not as bad as the former one; and the mice that is treated with graphite arc-derived CNTs that had a low concentration of carbon was not affected by granuloma. From this study, it can be inferred that CNT itself is harmful to an individual’s lung, and since it can easily leak out to the air, dangerous consequences could happen if actions are not taken.

Another evidence that supports the point made above about how carbon nanotubes can have such a negative effect on the air we breathe in is that

several scientists have found out CNTs tend to behave like asbestos – a hazardous fibre that was used in the past for insulation- which was responsible for a huge pandemic in the 20th century (Donaldson, 2013). Exposure to this fibre can result in cancerous diseases such as bronchogenic carcinoma and mesothilioma (Donaldson, 2013). Since asbestos are so light and small, even the slightest contact would result in their distribution into the air. CNTs may not be a widely used substance for now, but there is no guarantee that in the future it is going to be in a variety of products, and can potentially cause harm to people in the way that asbestos used to. Despite the threats that CNTs pose upon the air environment, when it comes to the water environment, this substance has an outstandingly good profile. They are being studied and tested for future usage as an effective adsorbent in the clean up of oil spills. The spill of over 600, 000 litres of fuel oil on the Gulf of Mexico in 2014 sparked a huge concern about how we are going to control and prevent unwanted releases of oil during extraction, transportation and storage, but more importantly, how to clean up the aftermath of the oil spills (Kabiri et al. , 2014).

According to Kabiri et al. (2014), zeolite, sawdust and wool fiber were natural materials that have been commonly used to remove oil, due to their characteristic, however, their adsorption efficiency is rather poor because they absorb both oil and water. CNTs, on the other hand, showed significant advantages compared to the traditional adsorbent materials, because they have high adsorption capacity and stability, which can make them easy to collect and reuse (Kabiri et al. , 2014). Apart from being used as sorbent for contaminants, CNTs can be used to make nanofilters to reduce particle

concentrations in water (Srivastava et al. , 2004; Jin et al. , 2007; Tahaikt et al. , 2007, as cited in Ong et al. , 2010). Their hydrophobic nature would make the water flow out easier, but other particles would get trapped in the CNT pores (Ong et al. , 2010). CNTs can also be helpful in the removal of pathogenic microorganisms like protozoa, bacteria and viruses in wastewater treatment by retaining the organisms on the surface of the CNTs (Bohonak and Zydney, 2005; Mostafavi et al. , 2009, as cited in Ong et al. 2010). In conclusion, the claim made by van Dooren in 2011 is only half correct. It is true that carbon nanotubes pose risks to living organisms lungs when they are inhaled, but it is also proven by studies that these tubes can help in water filtration and the cleanup of oil spills. This would give hope to marine life and would reduce the threat of extinction of many species. For the time being, studies regarding this issue might not yet be abundant, but that does not mean that we are subjected to neglect it.