

# Chemical Engineering Master's Defense

## Comparative Life Cycle Assessment of Sunscreen Lotion using Organic Chemicals versus Nano-Titanium Dioxide as UV Blocker

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### abstract

The production of nanomaterials has been increasing and so are their applications in various products, while the environmental impacts and human impacts of these nanomaterials are still in the process of being explored. In this thesis, a process for producing nano-titanium dioxide (nano-TiO<sub>2</sub>) is studied and a case-study has been conducted on comparative Life Cycle Assessment (LCA) of the application of these nano-TiO<sub>2</sub> particles in the sunscreen lotion as a UV-blocker with the conventional organic chemical sunscreen lotion using GaBi software. Nano-TiO<sub>2</sub> particles were identified in the sunscreen lotion using Transmission Electron Microscope suggesting the use of these particles in the lotion.

The LCA modeling includes the comparison of the environmental impacts of producing nano-TiO<sub>2</sub> particles with that of conventional organic chemical UV-blockers (octocrylene and avobenzone). It also compares the environmental life cycle impacts of the two sunscreen lotions studied. TRACI 2.1 was used for the assessment of the impacts which were then normalized and weighted for the ranking of the impact categories.

Results indicate that nano-TiO<sub>2</sub> had higher impacts on the environment than the conventional organic chemical UV-blockers (octocrylene and avobenzone). For the two sunscreen lotions studied, nano-TiO<sub>2</sub> sunscreen variant had lower environmental life cycle impacts than its counterpart because of the other chemicals used in the formulation. In the organic chemical sunscreen variant the major impacts came from production of glycerine, ethanol, and avobenzone but in the nano-TiO<sub>2</sub> sunscreen variant the major impacts came from the production of nano-TiO<sub>2</sub> particles.

Analysis further signifies the trade-offs between few environmental impact categories, for example, the human toxicity impacts were more in the nano-TiO<sub>2</sub> sunscreen variant, but the other environmental impact categories viz. fossil fuel depletion, global warming potential, eutrophication were less compared to the organic chemical sunscreen variant.



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