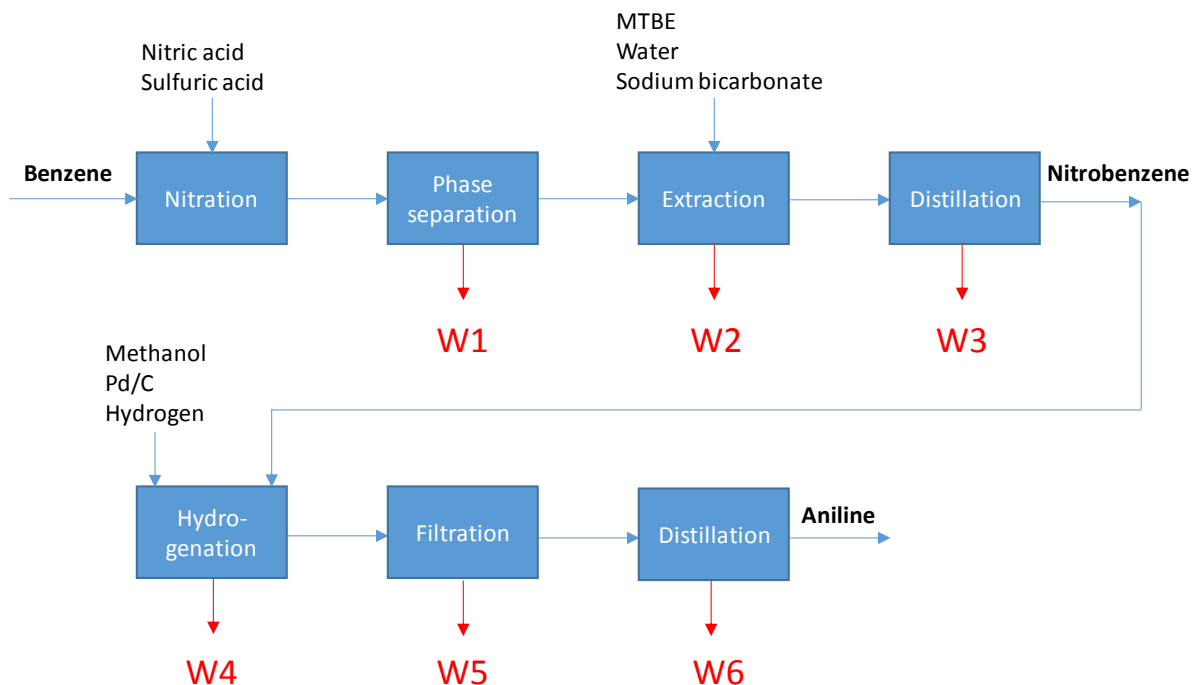
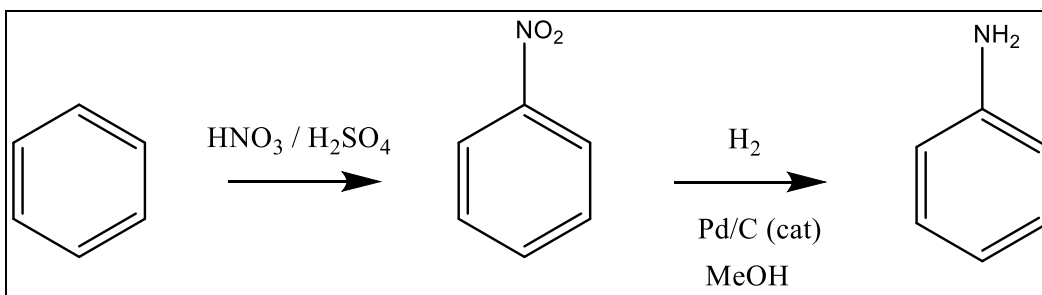


Quiz: Green chemistry / LCA

Green metrics & principles

Calculate the atom economy, carbon efficiency, reaction mass efficiency, generalized reaction mass efficiency and E-factor for the following synthesis of aniline. What type and amounts (estimated) of waste streams (in red on flow diagram) are produced? Propose ways of decreasing the E-factor. Identify and discuss some of the pros and cons of this process in the context of green chemistry.



| Nitration step | | Purity (w/w) | MW (kg/kmol) | Mass (kg) |
|----------------|-------------------------|--------------|--------------|-----------|
| IN | Benzene | 1 | 78.1 | 300 |
| | Nitric acid | 1 | 63.0 | 247 |
| | Sulfuric acid | 1 | 98.1 | 245 |
| | Methyl tert-butyl ether | 1 | 88.2 | 600 |
| | Sodium bicarbonate | 1 | 84.0 | 10 |
| | Water | 1 | 18.0 | 100 |
| OUT | Nitrobenzene | 0.987 | 123.1 | 469 |

| Hydrogenation step | | Purity (w/w) | MW (kg/kmol) | Mass (kg) |
|--------------------|--------------|--------------|--------------|-----------|
| IN | Nitrobenzene | 0.987 | 123.1 | 469 |
| | Methanol | 1 | 32.0 | 2200 |
| | Hydrogen | 1 | 2.0 | 26 |
| | Pd/C | | - | 2.3 |
| OUT | Aniline | 0.97 | 93.1 | 358 |

Green chemistry & LCA questions

1. Describe some advantages and limitations of the E-factor
2. Describe some advantages and limitations of Reaction Mass Efficiency
3. Define “burden” in LCA
4. Name and describe 4 impact categories in LCA
5. Give 2 examples of burden shifting
6. Why can dimethyl carbonate be considered as a “green” reagent and solvent?
7. Cite 2 substances causing water eutrophication
8. Cite 2 substances causing acidification

9. Cite 2 substances causing global warming
10. Name the reference compound for acidification
11. Which chemical is the main contributor to global warming worldwide?
12. Does N_2O have a higher ozone depletion potential than CFC-11?
13. Which sector is the largest contributor to global warming worldwide: transportation, energy, or manufacturing?
14. What is the main environmental issue with CFCs and what is their mechanism of action?
15. Which substance has the largest global warming potential: SF_6 , CFC-11 or CO_2 ?
16. Calculate the photochemical ozone creation potential for a process that emits 2.2 kg of methane, 0.2 kg of propane and 0.1 kg of 2-methylhexane per ton of final product.
17. Cite three possible boundaries of a LCA