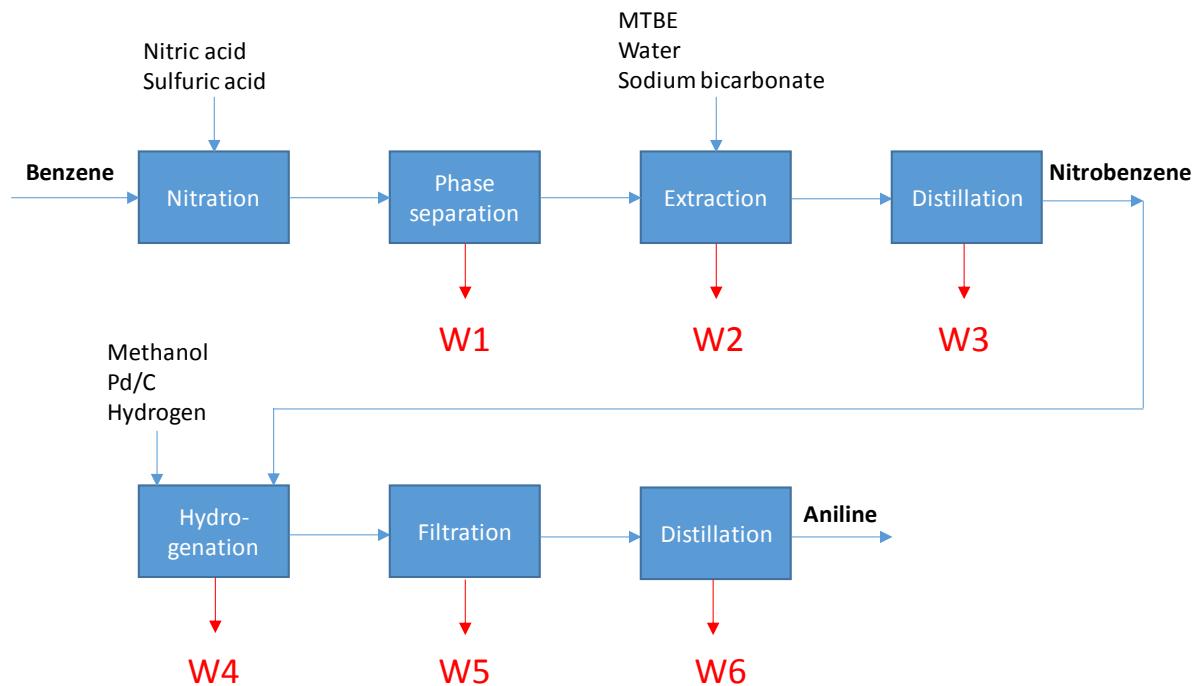
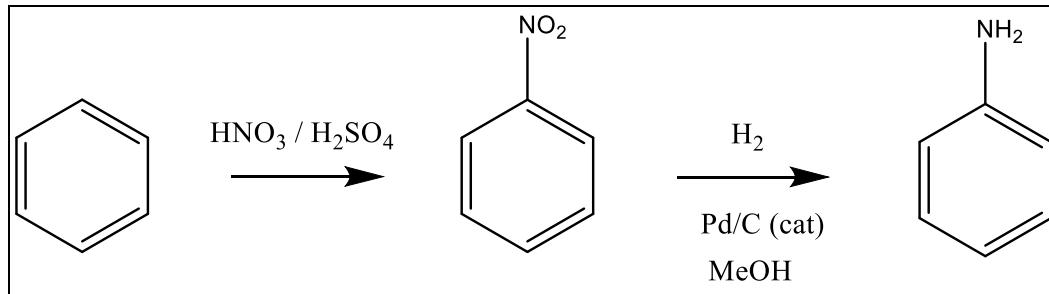


Quiz: Green chemistry / LCA

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 N₂O 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: SF₆, CFC-11 or CO₂?
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