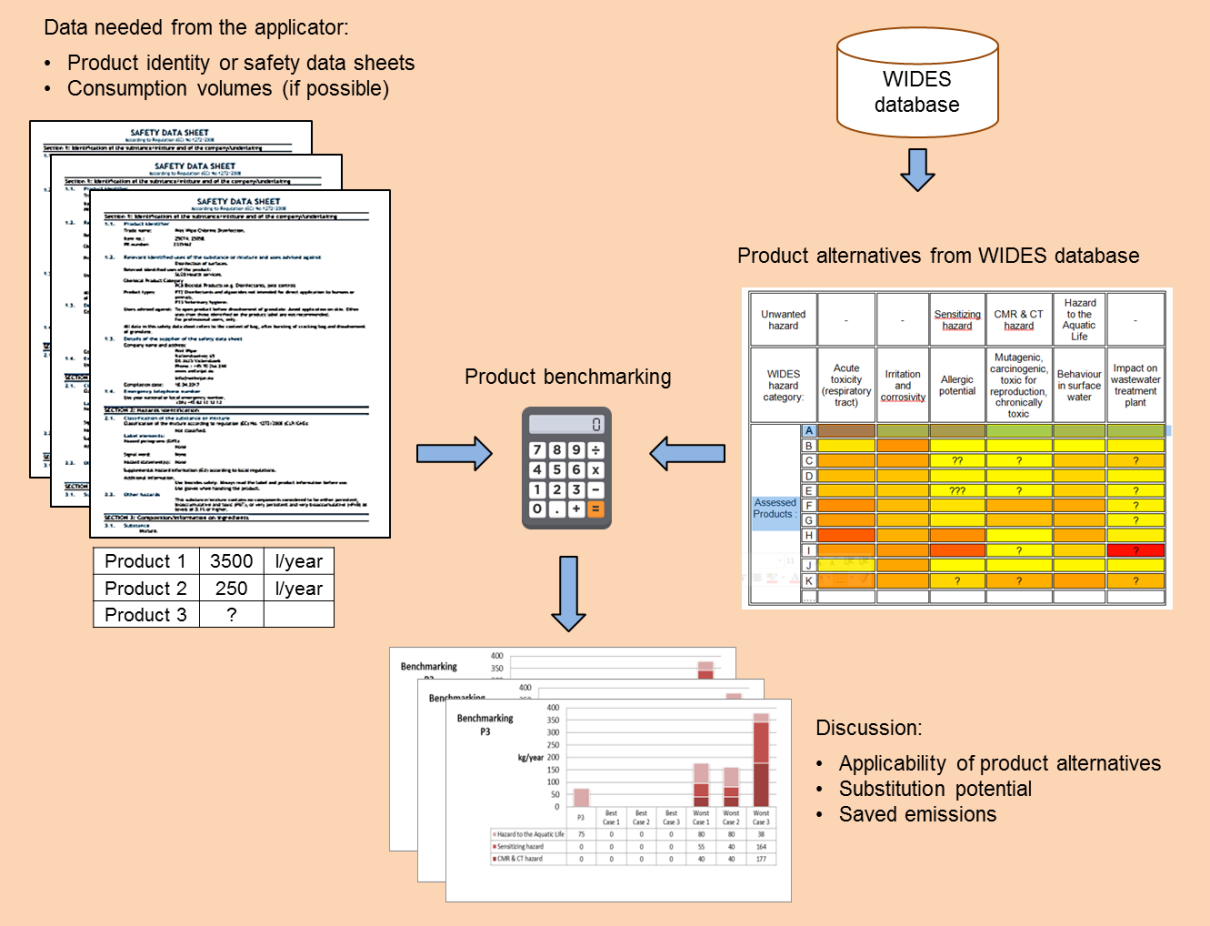
Product benchmarking of disinfectants

(A detailed explanation of the process)

Product benchmarking is the comparison of attributes of a product or product portfolio with a "benchmark". As a general rule the benchmark is the market leader in a particular product segment. The core element of the benchmarking is a comparative assessment fuelled by data from the applicators (hospitals, municipalities etc.) and data from the *Viennese Database for Disinfectants* (WIDES database).[1] The WIDES database thereby serves to select product alternatives. The benchmarked product and the selected product alternatives must match in terms of efficacy and application conditions. If the calculated emission loads of the product alternative(s) is (are) lower than that of the benchmarked product a substitution potential is assumed. The outcome of the calculation together with possible recommendations is finally communicated to the applicator. The following graph shows the core steps and data demand of the benchmarking process:

Figure 1: Product benchmarking of disinfectants



[1] The WIDES database actually includes more than 280 disinfectants available on the market for surface disinfection, hand and skin disinfection, and instrument and linen disinfection. See also: https://www.wien.gv.at/english/environment/protection/oekokauf/disinfectants/index.html

Case study benchmarking P3

The following case study explains and substantiates the subsequent steps of the benchmarking, the data needed, and the different ways to present the results. The case study was generated in the course of a consultation project for City departments of Vienna. Within the consultation TB-Klade benchmarked several disinfectants used for routine surface disinfection in public baths thereof the (anonymised) product P3 is presented:

1. Determining unwanted hazards

The benchmarking process first determines hazards that are unwanted and therefore should not arise from a disinfectant. The unwanted hazards threaten the human health and the environment and are specified as hazard statements.[2] Hazard statements are key elements of the Globally Harmonized System of Classification and Labelling of Chemicals (GHS) and indicate threats arising both from substances and products. For the benchmarking process, hazard statements from substances are considered. They are accessible in the safety data sheets of the disinfectants or on the website of European Chemicals Agency ECHA. In the case study it was decided to determine the following hazards to be unwanted:

Table 1: Unwanted hazards

Hazard statement		Affects
H340 H350 H360	May cause genetic defects May cause cancer May damage fertility or the unborn child	Health
H341 H351 H361	Suspected of causing genetic defects Suspected of causing cancer Suspected of damaging fertility or the unborn child	
H362	May cause harm to breast-fed children	
H317	May cause an allergic skin reaction	
H334	May cause allergy or asthma symptoms or breathing difficulties if inhaled	
H372	Causes damage to organs through prolonged or repeated exposure	
H300 H310 H330	Fatal if swallowed Fatal in contact with skin Fatal if inhaled	
H410	Very toxic to aquatic life with long-lasting effects	Environment
H411	Toxic to aquatic life with long-lasting effects	

[2] These criteria are a default and may be altered if wished by the applicator.

2. Investigating efficacy and application conditions

Benchmarked P3 and product alternatives must match in terms of efficacy and application conditions. Therefore investigating efficacy and application conditions of P3 is a necessary prerequisite for the selection of appropriate product alternatives. Knowledge of the use amount of the benchmarked product (litres or kilogram per year) has an added value because the benchmarking result then shows real emissions. If the use amount, however, is unknown - the benchmarking process can be still be carried out by using a default value (e.g. 1000 litres/year) - but in this case the result does not show real emissions.

Table 2: Investigating information about efficacy and application conditions of P3

Efficacy (Spectrum of activity)	Bactericidal (not Mycobacteria) and yeasticidal with clean conditions plus mechanical action	Imperative
Application	Surface disinfection with mechanical action (wiping), clean conditions	Imperative
Application concentration	0.5 % diluted in water	Imperative
Exposure time	1 h	Imperative
Certification of efficacy	Inventory of the Austrian Society for Hygiene, Microbiology and Preventive Medicine (ÖGHMP list)	Optional
Use amount product	1005 litres/year (Concentrate)	Optional

3. Ingredient list of P3 with classifications and concentrations

A list of ingredients including classifications and concentrations is prepared. The information can be taken from the WIDES database or provided by the applicator.

Table 3: Ingredient list of P3

Ingredient	CAS	Conc. (%)	Classification (hazard statements)
Isotridecanol, ethoxylated	69011-36-5	5	H315, H318, H412
N-(3-aminopropyl)-N-dodecylpropane-1,3-diamine	2372-82-9	7,5	H301, H314, H373, H400(M10), H410(M1)
Citric acid	77-92-9	2	H315, H319
Sodium etasulfate	126-92-1	5	H315, H318

4. Calculating emission loads for P3

For each ingredient with an unwanted hazard statement an emission load is calculated as:

$$Emission\ load\ = \sum_{i=0}^{n} \frac{\%\ ingredient}{100} \times use\ amount\ product$$

According to Table 3, the ingredient *N-(3-aminopropyl)-N-dodecylpropane-1,3-diamine* is classified with the unwanted hazard H410. With a concentration of 7.5% and a use amount of 1005 litres per year, the emission load is calculated to be 75L/year respectively 75kg/year since the density practically equals 1. No further ingredient of P3 shows an unwanted hazard so the benchmarking result of P3 can be expressed as follows:

The use of product P3 generates an annual load of 75kg substances with unwanted hazard. The calculated emission load affects aquatic life up to 100%.

Table 4: Calculating emission loads

Ingredient	% in Concentrate	Unwanted hazard	CMR &CT Hazard*	Sensitizing hazard**	Hazard to the aquatic life***
Isotridecanol, ethoxylated	5	-	-	-	-
N-(3-aminopropyl)-N-dodecylpropane-1,3-diamine	7.5	H410	-	-	75 kg / year
Citric acid	2	-	-	-	-
Sodium etasulfate	5	-	-	-	-

* = H340, H350, H360, H341, H351, H361 or H372; ** = H317 or H334; *** = H410 or H411

5. Choosing product alternatives using WIDES

As already mentioned, benchmarked P3 and product alternatives must match in terms of efficacy and application conditions. With known efficacy and the application conditions of P3, product alternatives can be easily filtered from the WIDES database.[3] In the case at hand this was done as follows:

- After login and opening the module *Products* the application *Surface Wipe Disinfection* was activated

[3] https://www.wien.gv.at/english/environment/protection/oekokauf/disinfectants/index.html

- In the drop-down list the exposure time *1h* and the spectrum of activity *bactericidal (not Mycobacteria) + yeasticidal, clean cond. + mechanic action* was selected and afterwards the button *Go to assessment* was pressed

The resulting list represents potential product alternatives for P3 together with their WIDES assessment (Figure 2). By applying this procedure the comparability between benchmarked P3 and the product alternatives is guaranteed. If P3 is already listed in the WIDES it will be part of the resulting list. Alternatively, comparability has to be ensured by collecting product specifications and certificates from manufacturers that may be a time consuming and tedious process.

Figure 2: WIDES list of potential product alternatives

WIDES Assessment:		Acute toxicity (respiratory tract)	Irritation and corrosivity	Allergic potential	Mutagenic, carcinogenic, toxic for reproduction, chronically toxic	Behaviour in surface water	Impact on wastewater treatment plant
Assessed Products:	A						
	B						
	C			??	?		?
	D						
	E			???	?		?
	F						?
	G						?
	H						
	I				?		?
	J						
	K			?	?		?
	....						

WIDES delivered 31 product entries, from which 3 “best case” products with a comparatively low hazard potential and 3 “worst case” products with a comparatively high hazard potential were selected. For the selection of product alternatives the WIDES assessment scheme[4] in six hazard categories is very helpful, shown as coloured fields:

- pale yellow = relatively low hazard
- orange = relatively medium hazard
- deep orange or red = relatively high hazard[5].

[4] The WIDES assessment scheme is explained in the document “Introduction in the assessment framework” available on the WIDES webpage https://www.wien.gv.at/wuawides/internet

[5] Question marks indicate data gaps in the underlying dataset.

Based on visual impression the selection of product alternatives inter alia gives the following result:

- Best case products are B and J since the colour fields in the hazard categories *Allergenic potential*; *Mutagenic, carcinogenic, toxic for reproduction, chronically toxic* and *Behaviour in surface waters* are pale yellow.
- Worst case products are F and K since the colour fields in the hazard categories *Allergenic potential; Mutagenic, carcinogenic, toxic for reproduction, chronically toxic* and *Behaviour in surface waters* are orange.

6. Making concentrates comparable

In the case at hand concentrates are benchmarked, then the following procedure has to be applied. Since both the benchmarked product P3 and the product alternatives have to be diluted prior to application, the calculation of the emission load has to be referenced to the amount of application solution and not to the amount of concentrate. Since for P3 the concentration of application solution is 0.5% and the annual consumption is 1005 litres concentrate this gives an (annual) application solution of 201 000 litres. Therefore the product alternatives also have to generate annually 201 000 litres of application solution. Different amounts of concentrates may not be unusual. If a product alternative is used with a 1% application solution, then 2010 litres of concentrate is needed to generate 201 000 litres of application solution (instead of 1005 litres for a 0.5% application solution).

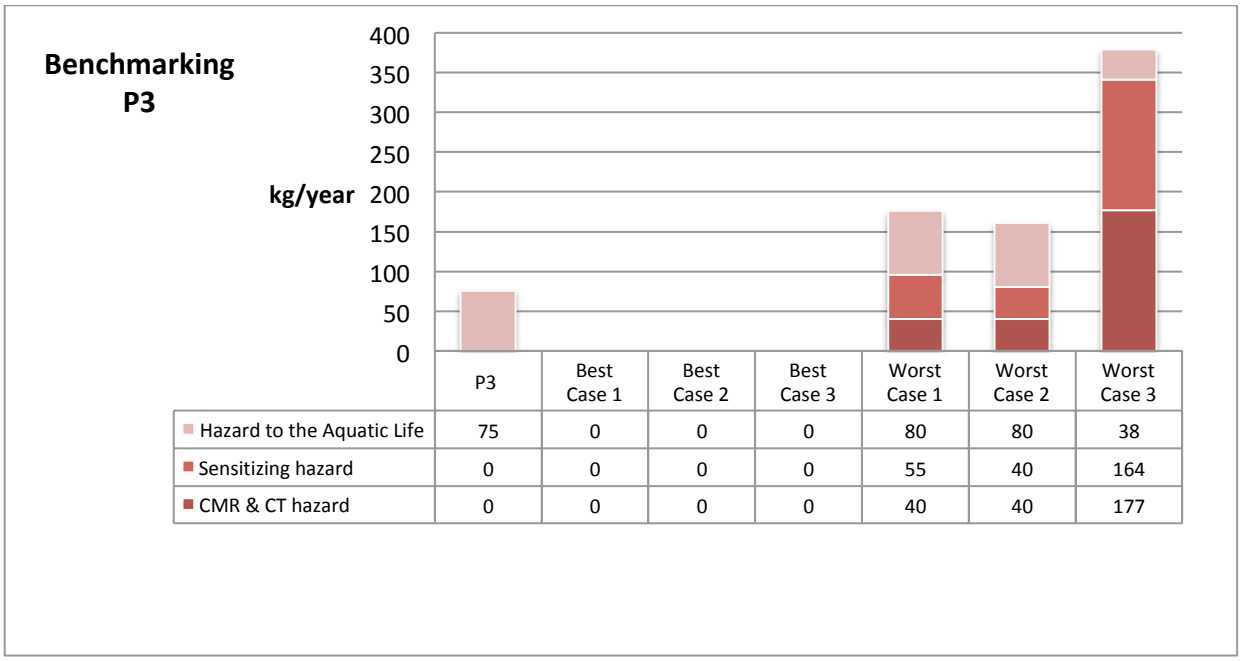
7. Presenting the benchmark outcome

The results can be presented in several ways, 3 options are selected:

Table 5: Emission loads of benchmarked P3 and product alternatives

Unwanted hazard	Relevant H-statement	Bench marked product P3	Best Case 1	Best Case 2	Best Case 3	Worst Case 1	Worst Case 2	Worst Case 3
CMR & CT hazard	H340, H350, H360, H341, H351, H361, H372	0	0	0	0	40	40	177
Sensitizing hazard	H317, H334	0	0	0	0	55	40	164
Hazard to Aquatic Life	H410, H411	75	0	0	0	80	80	38
Total load (kg/year)		75	0	0	0	175	160	379
Additional load compared to Best Case (kg/year)		75						
Load saving compared to Worst Case (kg/year)		85-304						

Figure 3: Emission loads of benchmarked P3 and product alternatives



	P3	Best Case 1	Best Case 2	Best Case 3	Worst Case 1	Worst Case 2	Worst Case 3
Hazard to the Aquatic Life	75	0	0	0	80	80	38
Sensitizing hazard	0	0	0	0	55	40	164
CMR & CT hazard	0	0	0	0	40	40	177

Figure 4: Overall conclusion/recommendation

The use of product P3 generates a load of 75kg substances with unwanted hazards. The load affects the aquatic environment up to 100%. There are products available on the market for the same application and with the same efficacy that emit 0kg of substances with unwanted hazard. With the limitation that material incompatibilities and working conditions are not explicitly taken into account, a substitution of P3 should be taken into consideration (potential for improvement).