Carbon footprint comparison RhobaAIR AIII Dry Wash - Conventional cleaning product

ALMADION distributes rhobaAIR AIII Dry Wash in the Middle East. RhobaAIR AIII Dry Wash is an alternative airplane dry cleaning product beside the conventional wet cleaning products. ALMADION is interested in getting an independent study comparing the carbon footprint of rhobaAIR AIII Dry Wash with conventional wet cleaning products. For this life-cycle approach, the typical use-case in the Middle-East region shall be analyzed.

The aim of this short report is to get a basic understanding of the CO_2e emissions related to the two cleaning processes at local conditions and to point out the highest emissions and uncertainties. To keep complexity at a reasonable level certain compromises had to be made and the focus is set on the most important processes. Thus, the calculation does not qualify for detailed product and process life cycle assessment, but shall describe a first overview. Input data from the employer were used by myclimate but not verified.

Based on this report it is to be decided if further investigation and more detailed calculations need to be performed.

Client:

ALMADION International LLC
P.O. Box 214969
Umm Ramool, Dubai
United Arab Emirates

Contractor:

myclimate - The Climate Protection Partnership
Sternenstrasse 12
8002 Zürich

Author:

Martin Suter

Internal Review:

Caroline Wildbolz

1 Carbon footprint methodology

For the determination of the carbon footprint, the global warming potential of the whole life cycle of the cleaning process is evaluated. This includes relevant raw materials, energy and water use, related transports and disposal. The method therefore refers to a life cycle assessment. For reasons of simplicity, certain areas have been left unconsidered in the initial assessment. The results of this calculation are only valid and comparable for UAE. This is mainly due to the specific UAE electricity mix and water treatment technology.

1.1 Functional unit

The functional unit describes what entity the climate impact is being calculated for. In this report, the functional unit is related to “One cleaning cycle of a passenger aircraft”. On an annual base it is assumed that the dry wash process only needs three cycles per year, whereas the wet wash process needs four. For a clear understanding of the process a single cycle has been analyzed and the annual usage factor applied on the final results.

1.2 Measurements of climate impact

Climate Impact (Greenhouse Gas Potential)

The most widely known greenhouse gas is carbon dioxide (CO2) and is generated for example through the burning of fossil raw materials. Beside CO2 many other greenhouse gases are emitted during processes, such as methane (CH4) or nitrous oxide (N2O). The greenhouse gas effect (global warming potential) of these gases can be expressed in a CO2 equivalent amount. The climate impact is therefore generally stated in the unit “kg CO_2e”, which means “kilogram CO2-equivalent”, within which the effect of all greenhouse gases over a 100 year period is added1.

The background data for the determination of the climate impact of the individual processes originate from ecoinvent version 2.2 2. ecoinvent is the biggest and mostly used data base for life cycle assessments.

---

[1] The indicator which is declared in “kg CO_2e” and demonstrates the climate impact is the “Global warming potential” on a period of 100 years (GWP 100a). For detailed information see “2007 IPCC Fourth Assessment Report”, chapter 2, online disposable.

[2] See www.ecoinvent.ch.

2 Data inventory

All data information, if not mentioned otherwise, has been provided by the client. In a first step, the carbon footprint will be based on the provided information. The data includes a technical data sheet of the analyzed product (ALMADION International LLC), a technical report on dry wash application trials from the client (ALMADION International LLC) as well as information provided by the client by email.

Further myclimate used internal estimations on the energy demand of desalination of water in UAE aimed to address local conditions. Beside this an internal study on industrial cleaning in Switzerland has been used to estimate the energy and water use needed for cleaning the dry wash application material (mops).

The two cleaning processes have been divided in four stages: Cleaning Agent, Cleaning Worker Personnel, Other Cleaning Martials and End of Life and are described in more detailed in the following sections. An overview of the assumptions made and data used is summarized in the following table.

While the conventional wet cleaning process uses a lot of regional scarce water and standard washing detergent, the dry clean process only applies the detergent on the aircraft surface and is polished and the dirt removed. On the other hand the application and polishing of dry clean agent needs a substantial amount of mobs that need to be washed and replaced.

Table 1: Data inventory per washing cycle.

Type	Unit	Rhoba AIR Dry Cleaning Value	Conventional Wet Cleaning Value	Assumption
Annual washing cycles	#	3	4	
Fresh water use	L	603.75	6000	Dry Clean Value water use derives from washing mops. Values equal to waste water treatment.
Weight of mops used	kg	0.525	na	300 mops with a re-use factor of 100 and product weight of 0.175kg.
Weight of mops washed	kg	52.5	na	All 300 mops washed after use.
Rhoba Dry Wash use	kg	75	na	Use of cleaning agent per cycle.
Conventional cleaning material use	kg	na	150	Use of cleaning agent per cycle.
Cleaning agent material transport	km	11110 (ship), 135 (Truck)	11110 (ship), 135 (Truck)	London UK – Dubai UAE, ship and truck.
Mop material transport	km	11960 (ship), 153 (Truck)	na	Bielefeld Germany- Dubai UAE, ship and truck.
Electricity use	kWh/ m^3	11.55(kWh)	6(m^3)	Electricity use for laundry of mops (kWh). Water pressure of conventional cleaning (m3).
External Laundry transport	km	20	na	Lorry transport from hangar to laundry and back.
Warm water use	kWh	106.05	na	Warm water use for laundry.
Cleaning workers transport	km	50	50	Workers transport from base to hangar and back.
Cleaning worker personnel	Person	20	10	Number of cleaning personnel needed.

2.1 Cleaning Agent

In this study the dry wash agent “Rhoba AIR A III” has been compared to a conventional washing method using water and standard agent. For the short report, the exact cleaning agent material composition was only known for Rhoba´s Dry Wash AIR A III.
For a fair approach both agents were modeled with the same attributes using “organic chemicals” as substitute to maintain a conservative approach.

Only the production of agent material was considered as well as its basic transport from London to Dubai (EcotransIT) with ship and truck as a rough estimation. Packaging and disposal as well as direct emissions from material loss from the airplane surface in the air are not considered.

2.2 Cleaning Worker Personnel

A main difference in the cleaning procedure is the manpower needed for cleaning an aircraft. It is assumed 20 workers are needed for a dry wash process while 10 for a conventional. Due to complexity and uncertainty only a basic transport for work route is included and assumed to be 50km in total by bus.

2.3 Other Cleaning Material

For conventional wet cleaning a water usage of 6000 liters per cycle have been assumed. Due to specific water resource condition in UAE where fresh water is usually desalinated and has therefore a higher energy demand, an internal study has been used for emission factor approximation. The study states that 99.9% of electricity is generated in co-gen processes with water desalination using natural gas as fuel; therefore CO_2e emissions are allocation to power and water production.

Additionally, emissions to produce pressure for 6 m3 are included in the LCA of a conventional washing process. No other material or transport where considered.

For dry wash cleaning it's assumed that 300 mops are in use for a washing cycle. The high number of mops represents a conservative approach as well as substitutes the application pads. A re-use (washing) factor of 100 is considered for mobs and material use spread over time, meanings only 1/100 new mops are accounted for a single cycle. Packaging is not considered. Transport route and distance of mobs from Bielefeld Germany to Dubai UAE has been estimated with EcotransIT (2012).

All mobs need to be washed; therefore a laundry of 52.5kg is assumed as well as its transport (20km) to a laundry facility and back. Based on an internal myclimate study on industrial laundry in Switzerland water (604 liters) and energy (11.55kWh electricity, 106.05kWh Gas) use are taken into account. Other materials like telescope sticks for agent application have not been considered.

2.4 End of Life

End of life treatment has been considered for water use of both cleaning processes using emission factors based on Swiss conditions for waste water treatment. Replaced mop material is assumed to be disposed in landfills.

3 Results

Based on the discussed assumptions and estimations, the conventional wet cleaning method assessment shows a carbon footprint (CF) of 496kg CO_2e per single cleaning cycle. The dry cleaning method with Rhoba AIR shows a CF of 240kg CO_2e per cleaning cycle which is half the footprint of the conventional method.

Taking into consideration the different number of cleaning cycles per year, Figure 1 shows the annual CF for conventional wet cleaning of 1983kg CO_2e and the annual CF for dry cleaning method with Rhoba AIR of 720kg CO_2e. The main difference in results is driven by the cleaning agent and other cleaning material.

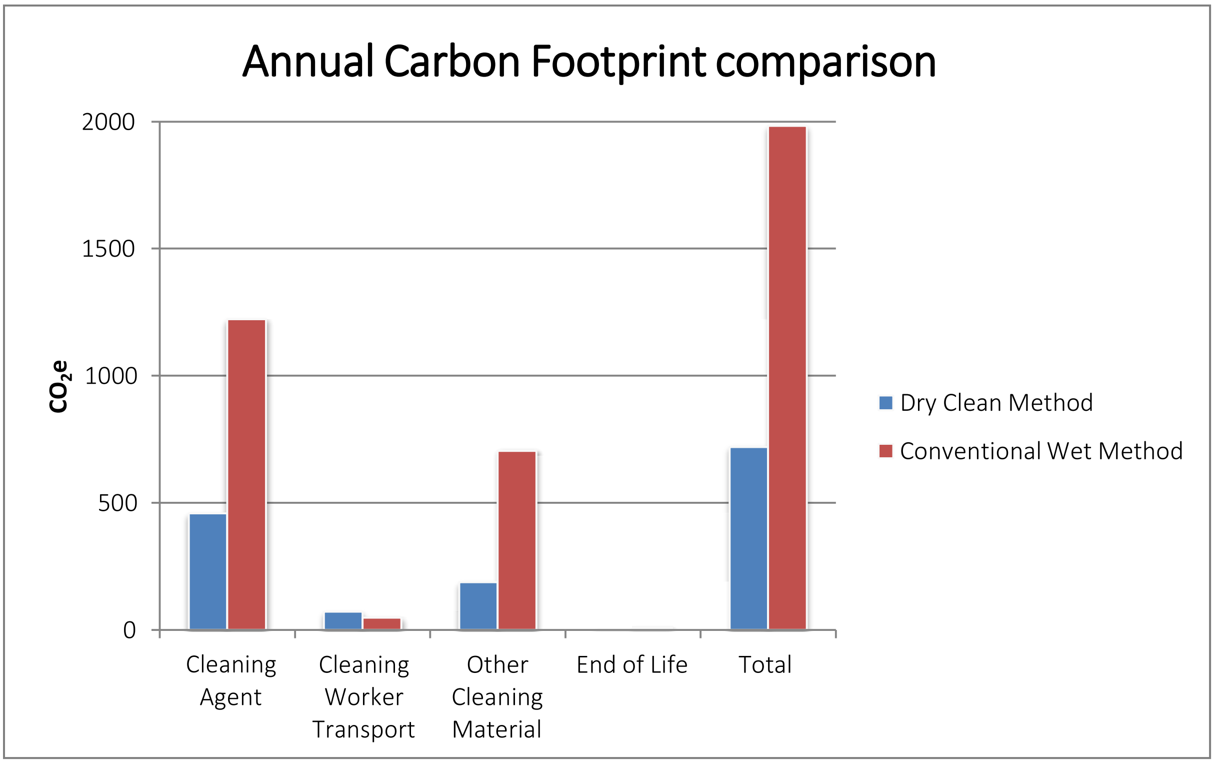

Figure 1: Annual CO_2e emissions comparison of airplane cleaning methods.

Table 2 shows annual emissions and percentage per stage and method.

Table 2: Annual CO_2e -emissions and proportion of the different stages.

Stage	Dry Clean Method		Conventional Wet Method	
	Emissions [kg CO_2e / year]	Portion	Emissions [kg CO_2e / year]	Portion
Cleaning Agent	458.2	63.7%	1221.9	61.6%
Cleaning Worker Transport	72.0	10.0%	48.0	2.4%
Other Cleaning Material	187.9	26.1%	703.6	35.5%
End of Life	1.6	0.2%	9.3	0.5%
Total	**719.7**	**100.0%**	**1982.8**	**100.0%**

Looking at the individual stages per cleaning cycle for the dry clean method in Figure 2 and for the conventional wet method in Figure 3, the pictures clearly show the main influence of the cleaning agent material. Because the same emission factor is used for calculating the agent material emissions, the difference results from different amount used. The agent has been calculated using a conservative approach and therefore might show lower emissions in reality. On the other hand packaging and end of life were not considered, which would increase the emissions associated with the agent. The two agents in each method are of similar nature; therefore a significant impact other than from the amount used is not expected but needs clearer observation.

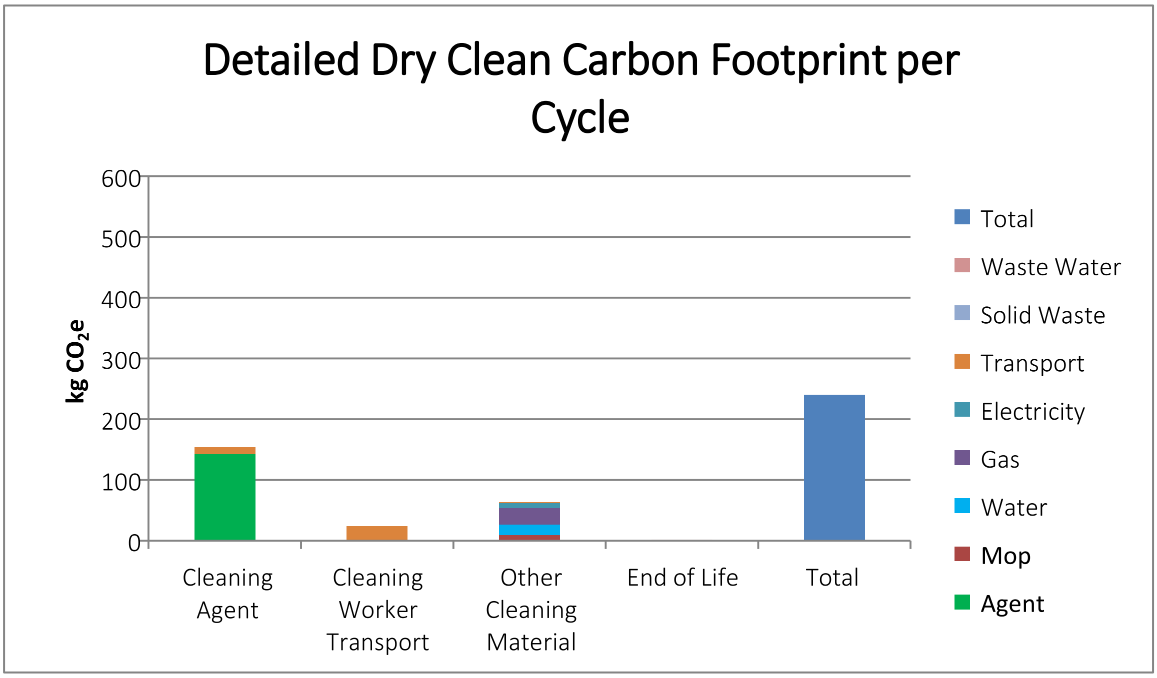

Figure 2: Detailed CO_2e emissions per washing cycle for Rhoba AIR AIII.

The other significant stage is Other Cleaning Material. For the dry clean method the emissions are driven mainly by water and gas (heat) use for cleaning of the used mops. In the conventional wet washing method the main influence is the high water use. The emission factor used for calculating emissions related to water preparation is based on the assumption that water has been desalinated in co-operation with electricity generation using gas. While this emission factor is much higher than the European average, it is still lower than assuming pure desalination operation. In the case of pure desalination water production, the emissions for water use would be higher and increase the footprint of conventional wet washing method even more.

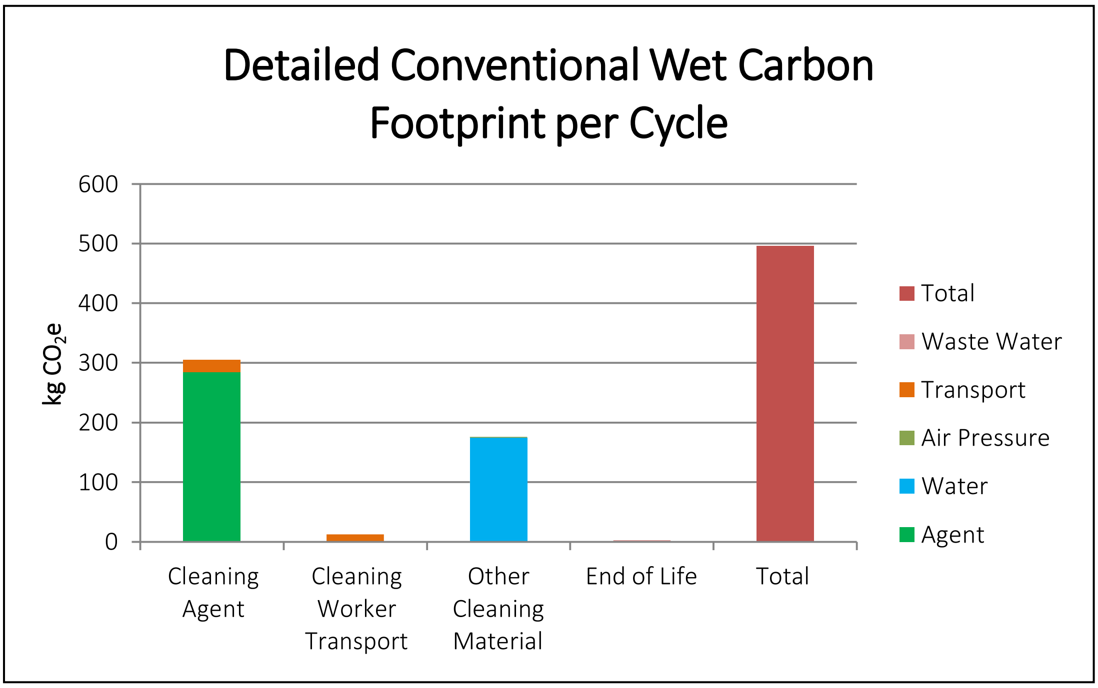

Figure 3: Detailed CO_2e emissions per washing cycle for conventional method.

4 Discussion

4.1 Data Assumptions

For a first comparison of each cleaning method, only existing client data has been used together with internal assumptions. For a clear understanding and higher detail of results it's important to re-evaluate used emission factors and data provided.

From the preliminary results it's clear that focus needs to be on stages Cleaning Agent and Other Cleaning Material. In the case of Cleaning Agent the agent material needs to be modeled in more detail as well as the amount needed per washing cycle validated.

For Other Cleaning Material assumptions made in regard to laundry of mops have to be verified as well as water preparation method and water use amounts.

4.2 Uncertainty and results

The preliminary results show a clear preference for the dry clean method using Rhoba AIR AIII agent resulting in half the carbon footprint size of a conventional wet cleaning method, even when looking only at one cleaning cycle.

While the show results of this comparison give a clear picture, the uncertainties related to rough estimates and used assumptions can be very high. Therefore it's strongly recommended to re-evaluate the calculation and data assumptions especially for the main driving stages and processes. Additionally it's recommended to assess some alternative scenarios for main influencing factors like clean water preparation.

References

ALMADION Int. LLC	A technical report on dry wash application trials conducted on Client Aircraft. Boessow A., Martelino J. F., Zschieschang O., Biesseman N, Dubai, UAE.
ecoinvent (2010)	Database ecoinvent data v2.2. Swiss Centre for Life Cycle Inventories. www.ecoinvent.ch
EcotransIT (2012)	www.ecotransit.org. Site accessed on 3.Mai 2012.
Frischknecht et al. (2002)	Frischknecht R., Jungbluth N. und ecoinvent Administratoren (2002): Arbeitspapier: Qualitätsrichtlinien ecoinvent 2000 des Schweizerischen Zentrums für Ökoinventare, Dübendorf. http://www.ecoinvent.org/fileadmin/documents/en/presentation_papers/Qualitaet_5.7.pdf
IPCC (2007)	IPCC (2007). Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. In: Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (eds.). Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 996 pp.