Typical „Product Carbon Footprint“ (PCF)-Values for Industrial Adhesives

Without the use of adhesives, the production of most of today’s devices and products simply could not be achieved. Adhesives enable the permanent joining of many different materials and parts.

In light of the above-mentioned numerous possibilities for joining different substrates, and also considering the many different production processes now in use, it is not surprising that there are thousands of different adhesives used in industry, in crafts and by end users. Although relatively few base polymers are used in adhesive manufacturing, adhesives with very specific properties can be designed by combining these base polymers with various modifiers and additives in the final composition.

In spite of their important function, the actual adhesive content is normally very low in a bonded product and is in most cases less than 1 % of the final product weight.

In light of recent efforts to render the manufacture of products and goods more sustainable, there has been an increasing interest in the „Carbon Footprint“ values of both products and processes. In spite of the fact that, as mentioned above, the adhesive content in a bonded product is fairly small; still, adhesive manufacturers are being asked for the PCF values of the adhesives they supply.

Several studies in recent years have shown that the PCF value of adhesives in the state in which they are supplied, (cradle to gate) with respect to the wide range of errors inherent to the PCF value calculation, can be clustered in certain product groups.

For the following product groups PCF values have been derived *:

- **Adhesives based on water-based dispersions**
- **Thermoplastic hot melt adhesives**
- **Solvent based adhesives**
- **Reactive adhesives**

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1) Adhesives based on water-based Dispersions

Several different base polymers are used for the manufacturing of aqueous dispersion adhesives. Normally these systems have a solids content of approx. 50 % (the remainder is water).

To make an adhesive with specific properties, a variety of additional agents are used, such as resins, plasticizers, thickeners etc.

The typical PCF values of these adhesives are in the range of 1 - 3 kg CO_2e/kg product independent of the base polymers and used modifiers and additives.

Adhesives which have a much lower solids content, or which have a significant content of inorganic fillers, may have even lower PCF values.

2) Thermoplastic Hot melt Adhesives

Hot melt adhesives are adhesives with an effective solids content of 100 %. The application of these adhesives is realized at elevated temperatures in the molten state; the substrates then bond together during the cooling process. In addition to the thermoplastic base polymers, other agents such as resins, waxes, oils and fillers are used to formulate the final adhesive.

The typical PCF values of these adhesives are in the range of 2 - 5 kg CO_2e/kg product independent of the base polymers and used modifiers and additives.

Hot melts, containing a significant amount of inorganic fillers, or raw materials as a by-product of a specific manufacturing process may have even lower PCF values.

3) Solvent Based Adhesives

Several different base polymers are dissolved in a range of different organic solvents for the manufacturing of solvent based adhesives. Normally these systems have large varying solids content.
To make an adhesive with specific properties, a variety of additional agents are used, such as resins, thickeners and others.

The typical PCF values of these adhesives are in the range of 2 - 5 kg CO_2e/kg product independent of the base polymers and used modifiers and additives.

Solvent based adhesives which have a significant content of simple organic solvent may have even lower PCF values.

4) Reactive Adhesives

„Reactive adhesives“ are a group of adhesives which depend on a chemical reaction to greatly increase the molecular weight and the internal strength of the adhesive and by which a liquid adhesive turns to a solid material, bonding the substrates to be joined.

Reactive adhesives are made from a larger number of different reactive agents, such as epoxies, polyurethanes, cyanoacrylates and others.

These adhesives are available as systems with 100 % solids content, or can be dissolved in organic solvents.

The typical PCF values of these adhesives are in the range of 4 - 10 kg CO_2e/kg product independent of the base polymers and used modifiers and additives.

Reactive adhesives containing a significant amount of inorganic fillers, or which have significant lower solids content, or which consist of special reactive components, may have either lower PCF values, or in very special cases also significantly higher PCF values, depending on the nature of the individual adhesive.

Summary

Typical Product Carbon Footprint (PCF) Values for Industrial Adhesives

Product Group	Typical PCF Values in kg CO_2e/kg Product
Adhesives based on water-based Dispersions	1 – 3
Thermoplastic Hot melt Adhesives	2 – 5
Solvent Based Adhesives	2 – 5
Reactive Adhesives	4 – 10

*The calculated PCF values (cradle to gate) were derived from respective data

- of environmental product declarations (calculated by PE International),
- of publications by industry associations, e.g. the EPDLA, and PlasticEurope,
- of publications on the Internet (e.g. Studies by the Öko-Institutes), or
- generated by member companies of Industrieverband Klebstoffe e. V., the German adhesives industry association.

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