

Article

Bio-based HSP Determination for Adhesive Applications

Sander van Loon & Beverley Fricker – May 29, 2020

TAGS: **Science-based Formulation** **Natural-based Adhesives**

Tighter regulations, sustainability targets and decreasing fossil fuel resources mean that lots of industries are looking to replace their solvents or to generally move to **greener chemicals**.

Adhesives use a wide range of components derived from fossil fuels, and with the prospect of these running out, **natural alternatives** are becoming more popular in the market.



With European norms to measure bio-based content or biodegradability in adhesives and sealants (**European Standards EN 16785-1** and **EN 13432**), the industry has already begun making this change.

Whether you are looking for green, plant based or just a different product, HSP will remove the trial and error of the process.

To learn more about the theory behind HSP, see [Professor Steven Abbott's Tutorial!](#)

Now, let's discover the bio-based alternatives with VLCI's existing HSP workflow using traditional solvents.

Selecting Bio-based & Green Solvents Using HSP

VLCI has been a **certified center for performing HSP determinations** since 2011, via a very efficient workflow. Now, this HSP workflow can be offered by using bio-based solvents.

VLCI has collaborated with many companies to obtain a **range of bio-based solvents** that are spread across the HSP space to perform the determination. These solvents will also be supplemented with few green solvents, that are found in the extremities of the HSP space, where no bio-based solvents currently lie to achieve the highest accuracy in our determinations until suitable bio-based solvents can be sourced to replace them.

<https://adhesives.specialchem.com/tech-library/article/biobased-hsp-determination-for-adhesive-applications>

With that, it is possible to practically determine the HSP of products using only these solvents and then based upon this, **recommend suitable replacements** or **predict their compatibility**. This selection of **bio-based solvents** is constantly expanding as more bio-based solvents are being released into the market.

So, what do we mean by these terms?

Plant-based products are a subgroup of bio-based products which, in turn, refers to **products wholly or partly derived from biomass**, such as:

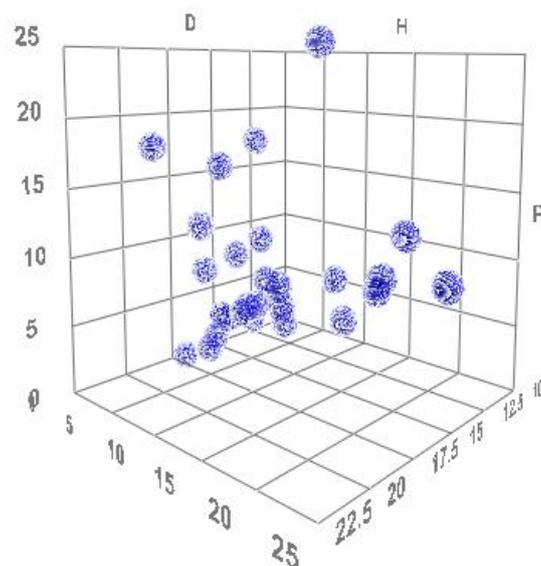
- Plants
- Trees or
- Animals

The biomass can have undergone physical, chemical or biological treatment³.

There is no universal definition of a **“Green Solvent”**, but usually the term refers to a solvent that has:

- Minimal health hazards (e.g. non-carcinogenic)
- Minimal safety hazards (e.g. non-flammable)
- Minimal environmental concerns based upon CLP/GHS analysis

...and then an analysis of the impact/efficiency of the manufacturing process is also taken into consideration.^{1,2}



The Bio-based Solvents in HSP Space

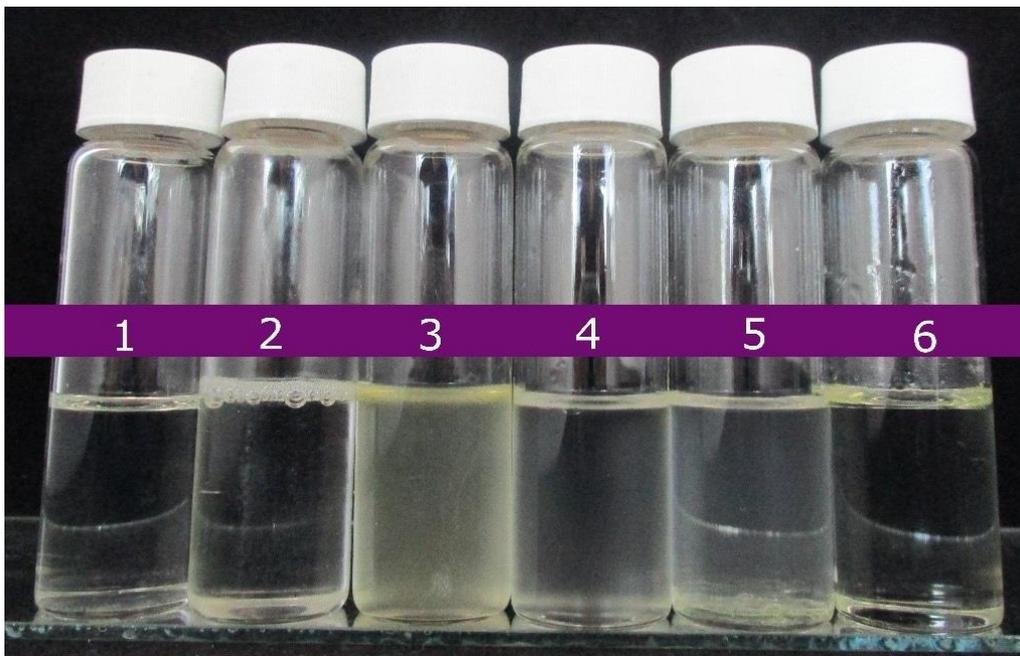
Validation of the Bio-based Test Method

Priplast™ 3186 by Croda, is a bio-based building block, that provides excellent hydrolytic stability and water repellency for cross-linked PU adhesives, foams and sealants.

- To validate our bio-based HSP workflow, the HSP of Priplast™ 3186 was determined using both the **standard HSP solvent selection** and the **bio-based solvent selection**.
- The HSP's were determined at a concentration of **0.1g in 5 ml of solvent**.

Priplast™ 3186 was added to the samples, shaken and left to dissolve. The samples are then visually assessed with a **qualitative rank from 1-6**, where –

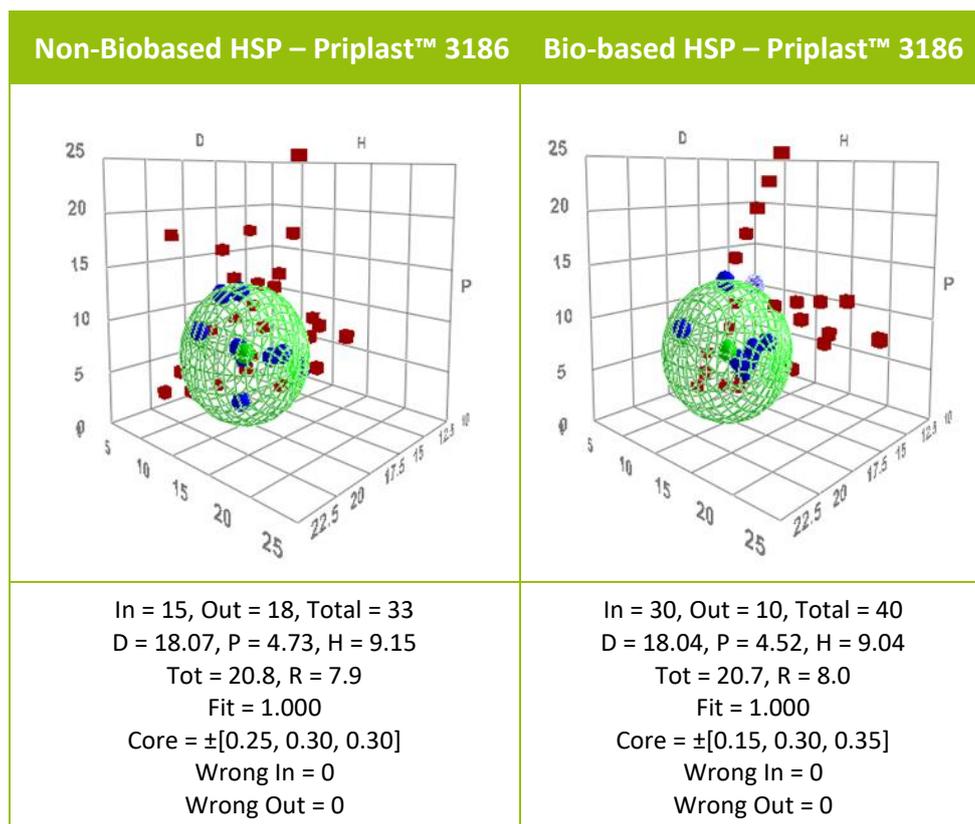
- A 1 means the product is completely dissolved.
- A 6 means there has been no interaction between the solvent and the product.
- The other scores indicating various stages of dissolution.



Visual differences and scores of Priplast™ 3186

This data is then entered into the **HSPiP Software**, which defines a spheroidal cluster of the solvents that dissolved the test material. This cluster is called the **Hansen Solubility Sphere**, and its central coordinates (δD , δP and δH) define the core solubility parameters of the test material.

The software also performs an analysis of the “**fit**” of the data to the parameters it has determined, highlighting the validity of the result, which can indicate if more experimental data is needed.



From the table above, it can be seen that the HSP determinations were successful using both workflows and serves as a validation that the bio-based solvents are suitable for use in HSP determinations. In this example, 30 Bio-based/green solvents and solvent blends showed complete compatibility with Priplast™ 3186.

For more details on how to practically determine an HSP, see our article [Predicting Ingredient Compatibility Using HSP in Adhesive Formulations](#).

Conclusion

Bio-based alternatives are in demand across the formulation industry. In this article, the HSP's of Priplast™ 3186 by Croda was determined using only bio-based and green solvents. These determinations were then successfully validated against **VLCI's existing HSP workflow using traditional solvents**.

- This demonstrates that the bio-based solvents are suitable for determining Hansen solubility parameters.
- And, in addition to this, it allows for immediate recommendations of bio-based solvents and oils that are compatible with the test material.

Knowing the HSP's of your materials allow for smart and efficient formulating and material replacement.

To learn more about how to implement HSP's, see our [other articles here!](#)

References

1. Adrien Benazzouz, Laurianne Moity, Christel Pierlot, Michelle Sergent, Valérie Molinier and Jean-Marie Aubry. 2013. "Selection of a Greener Set of Solvents Evenly Spread in the Hansen Space by Space-Filling Design." *Ind. Eng. Chem. Res.* 52: 16585-16597.
2. Denis Prat, Andy Wells, John Hayler, Helen Sneddon, C. Robert McElroy, Abou-Shehadad and Peter J. Dunne. 2016. "CHEM21 selection guide of classical- and less." *Green Chemistry* 18: 228.
3. European Committee for Standardization CEN. 2014. "EN 16575:2014 'Bio-based products – Vocabulary'."