What's in a name? Plastic definition and legislation

As a result of recent legislative developments regarding plastic waste management, the importance of clear definitions of plastic becomes apparent. The word plastic is used to describe a wide range of materials, but the materials that this includes and excludes can vary significantly. Without apropriate definitions for plastic in legislation, biobased developments devised with those very issues in mind may become prohibited.

What is a plastic?

Problems with plastic are at the forefront of the conversation when it comes to environmental issues. However, definitions on what a plastic actually is are rarely discussed.

From a technical point of view, plastics are moldable polymers, taking their name from the term plasticity – the ability to deform irreversibly without breaking.

Polyethylene and polypropylene are commonly seen plastics – two of the world's most widely used plastics and commonly seen in packaging. Polyethylene terephthalate (PET) too is used widely, in drinking bottles for example. Some lesser used plastics, and sometimes used as alternatives to these include polylactic acid (PLA), widely made from plant biomass and industrially compostable, and cellulose, the main component in plant cells but can be used to produce cellophane. There are many other examples, made both in nature and in factories.

However, how consumers define plastic can be somewhat different, almost as though the word plastic has come to mean nothing quantifiable. It simply represents a material that is bad for the environment. When people think of plastics, they think of single-use plastic bottles, straws and carrier bags strewn across road verges and beaches.

This can be seen walking down the 'plastic-free' isle in a supermarket, or at a cafe with 'plastic-free' cups and cutlery. Plastics like polypropylene, commonly used in packaging, have in some cases been replaced with alternative plastics such as PLA, as part of the drive towards limiting single-use plastics and improving sustainability. PLA is a biobased and industrially compostable plastic and presents environmental advantages when used in some packaging applications. Although it is still a plastic, it's biobased origins and compostability mean it is viewed by some stakeholders as being a completely different substance to a 'normal' plastic.

Polymers are produced by polymerizing smaller molecules called monomers. Traditionally polymers have been produced by taking monomers produced from crude oil and polymerizing them using chemical processes. However, is it possible to produce these monomers from renewable resources such as biomass, which when polymerised give synthetic biobased polymers. Polymers are also produced in nature, for example starch and cellulose, which can be processed to produce plastic. Finally, natural polymers, for example polyhydroxyalkanoates (PHAs), are produced by microbes, these microbes can be used in industrial facilities to produce large quantities polymers for plastic production.

The difficulty is, translating these variations in plastic production and properties into definitions to be used in policymaking.

EU single use plastic ban

In June of last year, the EU published its directive on single use plastics. The rationale behind this directive is clear: the EU is seeking to minimise the levels of plastic that end up in the environment through being inappropriately discarded. Single-use items that are disposed of incorrectly have been shown to cause great harm to wildlife and result in plastic microparticles permeating the oceanic ecosystem at damaging levels. The EU has opted to stem this problem at source, by restricting the use of single-use plastic items for which non-plastic alternatives exist on the market.

The Annex of the Directive defines plastic to be any polymer-based structural material, but excludes "natural polymers which have not been chemically modified". It is this latter point that is causing ripples across the biobased plastic sector: there is no available definition for a natural polymer.

What is a 'natural' polymer?

Cellulose predominantly comes from trees and as such is made naturally in abundance. Cellulose can be made into cellophane, a plastic used in packaging, by changing its secondary structure. This is done by processing to cellulose xanthate, then removing the modifications which turns the cellulose from a fibre to a film, but chemically is the same as the starting material. Despite being naturally occurring, this would be banned under the single-use plastic directive for having been chemically modified.

Polymers like PHAs would in fact be permissible under the definitions of natural polymer in the directive. However, the production of the same PHAs in an industrial fermenter could potentially be banned, regardless of the fact that it creates the same material as is made in nature.

As the aim of the Directive is to minimise plastic pollution, this then begs the question: in exempting "natural polymers" from the ban, is the EU targeting the right property? Plastic disposal is an issue unrelated to its production methods – if a synthetically produced polymer is identical to one produced in nature, why shouldn't it be exempt?

In an ideal world, as a means to combat litter and plastic pollution, the legislation would focus on changing social behaviour – preventing single-use plastics ever making it to the environment in the first place – but this would be tough to implement effectively. Alternatively, the focus could be on biodegradability and compostability rather than naturalness. The directive already makes steps in this direction by banning so-called "oxo-degradable" plastics, which have been shown to merely fragment in the environment, rather than truly biodegrade. However, the difficulties with exempting biodegradable plastics from the single-use plastic ban is a similar issue – there is no agreed standard for biodegradability. Whether in a river, on a beach or in a field, conditions in nature vary, consequently so does the rate of biodegradation.

Short of banning all single-use plastics that could make their way into the environment, targeting the right materials is a challenge. There are innovative plastics developed with composability or biodegradability in mind, and there are plastics that, despite being produced from naturally occurring biomass, must undergo chemical modifications during production. Furthermore, industrial biotechnology is of major importance for biobased polymer innovation. But the fact that further development and innovation in the field may be prevented, is an issue that should be addressed.

UK Plastic Tax

In 2022 the UK is aiming to introduce a tax on all plastic packaging that does not consist of 30% recycled content by weight, in order to stimulate a wider recycling effort and reduce plastic waste

that way. A consultation is underway with regard to this policy. The proposal is to tax at a rate of £200 per tonne on plastic which contains less than 30% recycled content.

Plastics will be produced with recycling in mind. As well as a reduction in plastic pollution, by creating a market for recycled plastic content, it is hoped the industry will become more circular and as a result, take steps towards tackling climate change.

What about compostables?

Compostable plastics offer a solution for hard to recycle plastics. They are able to be recycled, just not in the traditional sense. Composting is simply the recycling of organic matter.

Under the proposed wording for the tax, these plastics would not be exempt, thus effectively punishing compostable plastic producers for failing to solve a problem that they do actually solve. Indeed, a more circular economy is one of the aims of the tax, so exempting compostables does seem logical.

The UK's list of exemptions is even narrower than the EU's, only allowing cellulose-based polymers to be exempt from the tax, excluding PHAs. The UK Government's explicit intention behind this definition is "to avoid instances of novel plastics or blends being developed to avoid the tax", which is a sound rationale in theory (though it may be seen by some as needlessly cautious), but once again demonstrates a narrower view of what is a multifaceted problem with various possible solutions. This is not to mention the potential shown by other biobased plastics such as chitosan, made from the chitin of crustacean shells, which show innovative properties unobtainable from conventional plastics. Taxing these plastics could potentially stymie their development.

With both of these pieces of legislation due to come into force over the next two years, the biobased products sector will no doubt be keen for these definitions to be clarified so as not to tie the hands of readily available solutions for the problem of plastic waste. The question remains – should some of these biobased plastics be exempt from the proposed measures – and in which case where should the line be drawn?

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