Alternative Fuels & Chemicals Coalition

Advocating for Public Policies to Promote the Development & Production of Alternative Fuels, Renewable Chemicals, Biobased Products, and Sustainable Aviation Fuels

AFCC News & Reports – April 2020:
The "New Normal" for Bioplastics Amidst the COVID-19 Pandemic

Environmental Benefits for Bioplastics

As we adapt to the "new normal" due the transformation of life as we know it as the result of COVID-19, more and more widespread lockdowns and shelter-at-home orders are occurring.

The "new normal" is now becoming a way of life, with supply chains upended, and industrial biotechnology companies racing in creative ways to be considered essential businesses, so that labs can stay open, and new product development for the production of biofuels sales to hand sanitizer sales can progress.

As COVID-19 pandemic cripples the U.S. economy and corporate giants turn to Congress for help, a group of plastic industry and trade groups sent a letter to House Speaker Nancy Pelosi on April 16, asking Congress to allocate $1 billion to municipal and state recycling infrastructure in the next pandemic stimulus bill. It would be part of legislation known as the RECOVER Act, first introduced in Congress last November.

The silver lining in all of this, the impact on the environment, has become clear, air pollution in just about all major cities around the world has dropped an unprecedented amount, down 60% from the same three-week period last year spanning March and April when most of the global lockdowns were in effect. The number of hours with "unhealthy" air quality in New Delhi dropped from 68% in 2019 to 17% in 2020, and Los Angeles saw its longest stretch of clean air on record: 18 days.

Many of the hypothesized benefits of altering our economic and social behaviors are being realized in a mass, real-time experiment. This is a huge victory for sustainability, but these air pollutants will all return as the worldwide economy reopens.

A recent Harvard study estimates that COVID-19 may kill tens of thousands of Americans, because many of the pre-existing conditions that increase the risk of death in those with COVID-19 are the same diseases that are affected by long-term exposure to air pollution.

The Harvard researchers investigated whether long-term average exposure to fine particulate matter (PM 2.5) is associated with an increased risk of COVID-19 death in the United States. So,

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mitigating pollutants is doable through industrial biotechnology processes providing an environmentally cleaner planet by the production of bioplastics and recycling practices making these processes sustainable.

Bioplastics are Sustainable Alternatives and Environmentally Beneficial Compared to Fossil Fuel Plastics

There continues to be confusion that all bioplastics are made from plants and can break down completely in the environment. It does not! The term "bioplastics" is used to describe biobased plastics which are plastics made at least partly from biological matter and those bioplastics which are biodegradable plastics, that can be completely broken down by microbes in a reasonable timeframe.

Not all biobased plastics are biodegradable, and not all biodegradable plastics are biobased. And even biodegradable plastics might not biodegrade in every environment. According to Chemical & Engineering News, plastics recycling, as it exists today, is a mess. In 2015, the US recycled only 9.1% of the 31 million tonnes of plastics that consumers threw out, according to the Environmental Protection Agency.

The vast majority ended up in either landfills or incinerators. In contrast, two-thirds of paper, a third of metals, and a quarter of glass were recycled that year. In the European Union, about 14.8% of the roughly 27 million tonnes of plastic waste was recycled in 2016, according to the European Commission.

Technology as we know it today in bioplastics will provide innovative, viable, and most importantly, sustainable alternatives from sustainable feedstocks. Companies are striving to design 100% bioplastics which are recyclable, compostable, or biodegradable, and at the same time reducing society's carbon footprint relative to incumbent plastics and making our nation less dependent on fossil fuel consumer products.

This trend is most prevalent in the packaging industry. As more companies focus on reducing their dependence on crude oil and reducing the amount of waste in landfills and oceans, downstream users are seeking cost-effective, biobased alternatives for packaging, cosmetic ingredients, and other uses.

Governments and industry organizations are influencing the transition with standards or regulations either encouraging or mandating the use of environmentally friendly biobased products.

Consumers also are demanding greener and safer products. For example, one of the leading bioplastics which is polyhydroxyalkanoates (PHAs), known for its most intriguing biodegradability property, has physical properties which are often compared with polyolefins such as polyethylene and polypropylene.

The largest-volume bioplastic, polylactic acid (PLA), also breaks down, but only in an industrial composting facility. At the same time, there is a lack of support from policy makers to bring in the biobased and biodegradable plastics in lieu of fossil fuel based plastics in the global plastic waste policy debates.

Plastics and Bioplastics Usage in the Face of COVID-19 Pandemic

In the midst of a global pandemic, COVID-19, appears to have given plastics a more important role due to the need to securely protect ourselves by wearing plastic face shields or working behind plastic shields, ensuring food and personal items are protected with impermeable packaging, and providing gloves for every day use.

Plastics are a key material for a wide range of industrial applications: automotive, aerospace, electronics, and healthcare, to name a few. In healthcare, plastic is indispensable in its ability to maintain sterility and provide medical devices such as syringes, insulin pens, pacemakers and prosthetics.

However, a majority of these products come from fossil fuel feedstocks, and thus contribute to the global plastic waste problem. Unfortunately, the low production volumes for bioplastics, has resulted in the use of fossil fuel plastics for these applications during the COVID-19 pandemic.

Global bioplastics production currently is just a fraction of the more than 359 million tons of plastic produced annually. Global bioplastics production in 2019 was 2.11 million tons, and growth is expected to be modest, reaching 2.43 million tons in 2024 – still less than 1% of annual plastics production.

The biobased economy provides environmentally friendly alternatives to fossil fuel plastics, providing plastics that are recyclable, biodegradable, and compostable.

There are some recent new bioplastics innovations and uses emerging which will foster wider-scale bioplastics adoption and supportive public policies. For example, 7-11 Japan switched to plant-derived bioplastic wrappers for all rice ball offerings at in July 2019. Similarly, Germany has supported the use of certified bio-based and compostable biowaste plastic bags since 2015.

While still a relatively small and nascent market, there have been some exciting bioplastics innovations lately. For example:

- bioplastic containers made from rice starch with a high degree of thermal resistance and mechanical strength,

- edible bioplastic food wrappers made from corn and shellfish byproducts, and
- some Lego kits that now contain sugarcane-derived bioplastics.

These new innovations could in the immediate future reduce dependence on fossil- fuel-derived plastics, improve our carbon footprint, and mitigate pollutants thus providing a cleaner and healthier environment.

Methodologies for Recycling Bioplastics or Plastics (Mechanical vs Chemical)

There are tremendous technological efforts ongoing to recycle bioplastics and fossil-fuel-derived plastics. These include the use of depolymerization, pyrolysis, or other methods to break plastics down and recovering the raw materials from which the plastics were synthesized. These processes are called chemical recycling which offer a promising way to turn used bioplastics/plastics into renewable chemicals or fossil fuel chemicals for use in new products with a minimum amount of waste.

For example:

- Brightmark's forthcoming plastics-to-fuel plant in Indiana will use pyrolysis to convert mixed single-use plastics sourced from Indiana and Chicago-area waste and recycling companies into a hydrocarbon liquid that can be processed into commercial-grade ultra-low-sulfur diesel, naphtha, and wax.
- Carbios has optimized an enzyme that in just 24 hours depolymerizes polyethylene terephthalate (PET) into terephthalic acid and ethylene glycol in a 97% yield.
- Primordial Genetics is collaborating with scientists at the National Renewable Energy Laboratory to help solve the plastic problem by developing enzymes using synthetic biology, capable of breaking down PET into its starting monomers.
- Pyrowave is using technologies such as catalytic microwave depolymerization to break down polystyrene to styrene monomer which can be used to create new, virgin-like plastics.
- Tyton Biosciences is recycling discarded clothing as well as PET using supercritical water technology to generate the monomers terephthalic acid and ethylene glycol.
- Agilyx is converting difficult-to-recycle waste plastic into a synthetic crude oil that is sold to refineries to make gasoline, lubricants, and even in some instances plastics.

These upcoming companies are mentioned in a recent Discovery Report, published by Chemical & Engineering News.

Bioplastics from renewable resources which are sustainable can be recycled using either mechanical or chemical processes (which includes industrial biotechnology processes), just as with fossil-fuel-based plastics.

The only problem with mechanical recycling or conventional recycling is that waste plastic that is collected, sorted, cleaned, shredded, and then melted down and pelletized to be reused, loses some of its original physical and mechanical properties, and eventually has to discarded contributing to the environmental plastic pollution.

Moreover, less than 10% of all the plastic trash ever produced has been recycled.

What's Next?

The recycling of bioplastics plays an important role in the biobased economy, which would entail turning bioplastics and fossil fuel plastics waste into new value-added materials.

There is an urgent need to develop and implement new technologies for the recycling of polymeric waste, going beyond traditional mechanical recycling. Chemical recycling is a path forward in managing bioplastic and fossil fuel plastic waste.

New technologies for the recycling of polymeric/bioplastic waste via chemical recycling would assist in expediating the prevention of plastic waste in oceans and landfills, and would be an environmental game-changer, especially for those biobased or fossil fuel polymeric materials which are difficult to recycle.

Furthermore, investments made in these new chemical recycling technologies will lead to creation of new jobs nationally, and mitigate greenhouse gases, thereby providing a healthier environment for the United States.