Cargill Dow

NatureWorks™

Situation

Company background

Cargill Incorporated and The Dow Chemical Company have formed a stand alone joint-venture, Cargill Dow, to manufacture and market polymers for producing fibers and packing materials that are derived entirely from annually renewable resources.

Cargill Dow Polymers was formed in 1997 as a 50/50 joint venture between Cargill Incorporated and The Dow Chemical Company. The Dow Chemical Company is a global science and technology-based company that develops and manufactures a portfolio of chemicals, plastics and agricultural products and services for customers in 168 countries around the world. With annual sales of more than US$18 billion, Dow conducts its operations through 15 global businesses employing 39,000 people. The company has 123 manufacturing sites in 32 countries and supplies more than 3,500 products.

Cargill is an international marketer, processor and distributor of agricultural, food, financial and industrial products with some 82,000 employees in 59 countries. While Cargill Dow is a stand-alone business, it will continue to leverage the agricultural processing, manufacturing and polymer expertise of the two parent companies in order to bring the best possible products to market.

The new, patented technology to emerge from this venture is called NatureWorks™. This product is a family of fibres and packaging polymers made from annually renewable resources, which combines performance and cost competitiveness with outstanding environmental benefits. By applying their unique technology to the processing of natural plant sugars Cargill Dow have created a proprietary polylactide polymer, which will reach the consumer in clothes, cups, packaging and other products.

Targets

The aim of the Cargill Dow venture was to produce revolutionary products that don’t change lives. That is, their goal is to change the world, but with technology that does not require a sacrifice of things such as product quality. To do this Cargill Dow sought to replace petroleum-based resources with annually renewable ones - such as corn and other plants. Hence, unlimited resources replace scarce ones.

The mission of Cargill Dow is essentially to provide continuous innovation fuelled by the company's financial profits that in turn allows them to balance economic growth, social responsibility and environmental protection. For Cargill and Dow, the joint venture provides a tremendous opportunity for both corporate parents to revolutionize the polymer industry and expand the technology's use across a broad range of applications.

Now vice president and chief technology officer for Cargill Dow, Pat Gruber, who began exploring such an innovation some years ago, tells "I wanted to do something that would change the world for the better, and had realistic and substantial business applications to encourage its widespread use."

Actions

Before joining Cargill Dow, Gruber had already been exploring development of such a product about 12 years ago while he was working as a research scientist for Cargill. Initially this began as a small-scale research project, while he was examining possible new uses for corn matter derived from corn wet milling processes.

Prior to this several companies had been looking into developing plastics from lactic acid, but with no success. For Gruber, feedback was initially not positive, as many chemical companies told him that he would never find a low cost supply of lactic acid for this product.

Achieving this technological breakthrough didn't come without some bumps and detours for Gruber, but in time his efforts did meet with success. He persevered in his explorations and eventually found the ideal resource in corn - something he had been working with already for some time. From this he designed a process of fermentation and distillation to create a polymer suitable for a broad variety of applications from the renewable resource corn.

As an agricultural firm, Cargill had taken it as far as it could by 1997. The company needed an associate with access to chemical markets and polymerisation capabilities, and Dow Chemicals was identified as the ideal partner. The next step was formation of the joint venture that created Cargill Dow, and the first product, a corn-derived polymer: NatureWorks™.

The process for making NatureWorks™ begins with natural plant sugars derived from agricultural crops like corn and uses a fermentation process to create lactic acid, a common food additive; this lactic acid is used as a food additive and is found in muscle tissue in the human body. Through a condensation process a lactide is formed, and this is then purified through vacuum distillation. The final refining step to create the polymers is polymerization of the lactic using a solvent free melt process.

Development of this new technology allows the company to "harvest" the carbon that living plants remove from the air through photosynthesis. Carbon is stored in plant starches, which can be broken down into natural plant sugars. The carbon and other elements in these natural sugars are then used to make NatureWorks™, which will reach the consumer in clothes, cups, packaging and many other everyday products.

Current manufacturing capacity at the plant near Minneapolis is more than 4,000 metric tonnes of polymers per year. Plus, Cargill Dow announced plans early in 2001 that it is to build a world-scale facility in Blair, Nebraska at the Cargill corn wet milling plant. The plant, the first of its kind in the world, will allow for an annual production capacity of 140,000 metric tonnes of NatureWorks™ polymers when it comes on-line in late 2001. The new plant will enhance Cargill Dow's ability to meet rapidly growing international demand for NatureWorks™. This new plant will also see the creation of new jobs and a new market for producers of agricultural crops. In addition, Cargill Dow expects to begin construction of a large-scale European plant in two years.

Results

Gruber's team of researchers perfected the physical properties of the PLA to the point where it is now actively competing with traditional materials in packaging and fiber applications throughout the world; based on the technology's success and promise, Cargill Dow is quickly becoming a premier player in the polymers market. This new polymer now competes head-on with nylon, polypropylene, polyethylene, polystyrene, and cellophane, as well as natural materials such as wool, cotton, and paper.

A wide range of products that vary in molecular weight and crystallinity can be produced, and the blend of physical properties of NatureWorks™ makes it suited for a broad range of fiber and packaging applications. Fiber and non-woven applications include clothing, wipes, carpet tiles, diapers, upholstery, and interior and outdoor furnishings; packaging applications include packaging films, food and beverage containers, coated papers and boards.

As NatureWorks™ polymers are more oil- and grease-resistant and provide a better flavor and odor barrier than existing chemical polymers, companies packaging products such as cooking oils and health and beauty products are beginning to evaluate this alternative. And, the ability of NatureWorks™ to be composted has drawn attention from fast-food chains and food packagers, who are considering this as a possible alternative for food containers, cups and plastic ware. Initially Cargill Dow saw that NatureWorks™ would be mainly used for packaging, however with the market opportunities being much larger than initially predicted the company are now seeing growing opportunities in both packaging and fiber applications.

As new companies begin to explore this family of polymers, new potential applications are being identified. For example, NatureWorks™ polymers possess two properties that have been identified as being particularly useful for drape fabrics, window furnishings, and outdoor furniture. Their resistance to ultraviolet light is particularly appealing as this reduces the amount of fading in such fabrics, and their refractive index is low, which means fabrics made from these polymers can be made with deep colors without requiring large amounts of dye. In addition, sportswear makers have been drawn to the product as it has been recognized as having an inherent ability to take moisture away from the skin and when blended with cotton and wool, the result is garments that are lighter and better for absorbing moisture.

NatureWorks™ combines a very inexpensive large-scale fermentation with chemical processing to produce a value-added polymer product that improves the environment as well. The source material for NatureWorks™ fibers is natural sugar found in plants such as corn and using such renewable feedstock presents several environmental benefits. As an alternative to traditional petroleum based polymers, production of NatureWorks™ uses 20%-50% less fossil fuel and releases a lower amount of carbon dioxide than comparable petroleum-based plastic; carbon dioxide in the atmosphere is removed when the feedstock is grown and is returned to the earth when the polymer is degraded.

Disposal of NatureWorks™ fits with all disposal systems with the additional option of being fully compostable in commercial composting facilities. Long-term, with the proper infrastructure, NatureWorks™ could be recycled back to monomer and re-used as a polymer. Thus, at the end of its lifecycle, a product can be broken down into its simplest form, with no sign of any remains. And because the company is using raw material that can be regenerated year after year, it is both cost competitive and environmentally responsible.

Gruber, has just been named a recipient of the Discover Award for Environmental Innovation, presented by the Christopher Columbus Fellowship Foundation. Further, the U.S. Department of Energy has awarded Cargill Dow more than US$2 million for continued research and development of the company's fermentation process for utilization of renewable resources. The funding was awarded in support of the President's Executive Order to triple the use of biobased products and bioenergy by 2010.

Cargill Dow is now working on modifying the fermentation process so that the NatureWorks™ technology can use other annually renewable resources such as wheat, sugar beets, and agricultural waste as feedstocks. The expectation by the company is that production will more than triple to one billion pounds of polymer within seven years.