Sustainability in the Polymer Industry

J. D. Hensel, R. A. Schwarz, C. W. Grispin

Polyflow Corporation
henseljd@polyflowcorp.com Tel: 330-253-5912
526 S. Main St, Ste 230, Akron OH 44311-4413

ABSTRACT

Polyflow Corporation is commercializing a revolutionary process technology that will truly recycle mixed and dirty plastic and rubber trash into monomers and solvents. Polyflow cracks plastic and rubber waste as an alternative to crude oil and natural gas to make feedstock for engineering polymers, and can reduce the USA's dependence on foreign oil by 3.5% (and up to 7%) when fully implemented. Polyflow will be the world wide process of choice for the disposal of plastic and rubber waste. Polyflow eliminates particulates and reduces by 70% the greenhouse gas emissions produced by the incineration of plastic and rubber waste.

The patent-pending Polyflow process is now run in ½ ton batches. The quality of the product and utility of the feedstock has been proven using random mixes of scrap polymers.

The Polyflow technology promises to be one of the most meaningful advances in the polymer industry in years. Its impact is far reaching.

Keywords: polymer recycling, alternative energy

1 DEVELOPMENT TASK SUMMARY

1. Demonstrate the chemistry by reconditioning and running a full scale batch processor.
2. Validate a continuous process by the construction and operation of a section of a full size continuous production processor.
3. Position to generate revenue through the sale of technology, engineering and administrative services, and plants to the petrochemical industry, waste industry and municipalities.

2 VALUE PROPOSITION

The Polyflow technology is a cracking process similar to that used in the petrochemical refineries, but at conditions that enable Polyflow to use plastic and rubber waste as a feed stock in place of crude oil. For every ton of polymer feedstock, Polyflow can produce 0.7 tons of light hydrocarbon liquid, 70% of which is aromatic and most is styrene monomer. The product can be refined using common distillation and extraction technology. The fact that Polyflow produces high value, light hydrocarbon is key and the subject of Polyflow's world wide patent applications.

Of equal importance is the fact that the Polyflow process uses as feedstock mixed plastics and rubber. Polyflow can even use as feedstock, polymer products that most people have forgotten are polymers, like carpet. The process can accommodate fillers and contaminants such as carbon, wire, fiberglass, paper and metals. This means that in a municipal area like Cleveland/Akron, within a 25 mile radius there is enough accessible polymer waste to feed 5 Polyflow processors.

A low cost feedstock available in excess and a high value product in strong demand make a compelling business model. A layered investment plan, multiple revenue streams and several exit strategies provide a worthwhile opportunity.

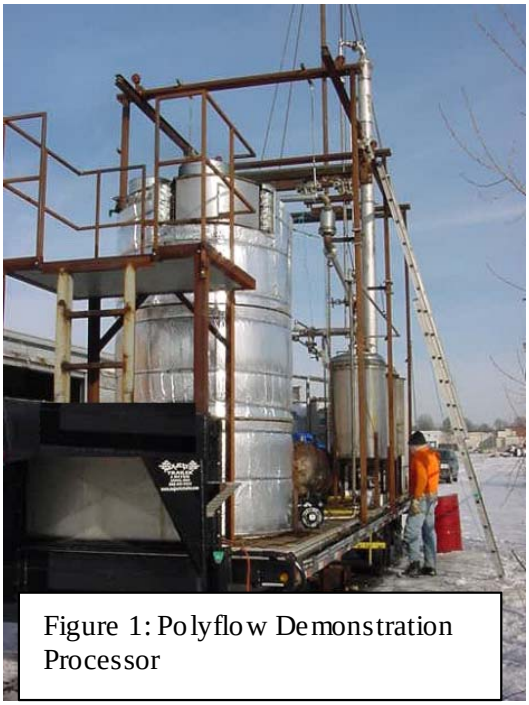

Figure 1: Polyflow Demonstration Processor

3 DEVELOPMENT STATUS

The key attributes of the technology, that it takes mixed polymer waste, and that it produces high value products have been proven by the inventor and demonstrated in an at-scale 1000lb batch demonstration processor. Polyflow is seeking investments to build a phase 2 production processor that is required for the evolution from a batch to a continuous process and the design of a production facility. This processor will act as the commercialization pre-production facility and evolve to be the primary research facility in support of efforts to commercialize this technology on a domestic and then global scale.

Polyflow Corporation was formed in 2005, in Akron, Ohio. A detailed business plan has been prepared for Polyflow Plant #1 LLC, and is a projection of the high financial returns possible through the commercialization of the technology. Each plant in each municipality will have a production revenue potential over $100 million annually.

Global patents are pending through the Patent Cooperation Treaty. These filings were made in April 2007 in the US, Australia, Brazil, Canada, China, EPO, India, Indonesia, Mexico, Philippines, and Korea. A Taiwan patent is pending. The US equipment patent has been allowed. A commercialization team is in place. The technology has already been accepted in principal by at least two major petrochemical companies and commercialization agreements are pending.

To facilitate the sale of the first plants, and to gain potential government support, potential sites for Polyflow Plant #1 in the Cleveland Akron area and in Cincinnati have been identified. Polyflow now has formal contracts on the supply of a portion of the raw materials and is pursuing additional agreements. Polyflow is in discussions with petrochemical industry strategic investors that will purchase the products of Polyflow Plant #1.

4 COMMERCIALIZATION GOALS

The primary product of Polyflow Corporation will be production plants. The terms of the sales are yet to be defined, but a likely scenario will be the licensing of the technology for a specific plant in exchange for a fee and an equity position in the plant. In addition Polyflow will offer services including plant design and engineering, plant management, and consulting. There is also the opportunity to offer a consolidation and sales service for the products from multiple plants.

4.1 Polyflow Plants

Polyflow Plants reclaim the petroleum content of post-consumer and post-industrial plastics and rubber wastes and produce styrene, limonene, and high octane gasoline blend products. These are highly profitable and well-established commodity chemicals that are usually derived from crude oil. The primary product, styrene is separated and sold to the major engineering polymer manufacturers like Nova Chemical, GE, and Goodyear. The limonene is sold as a solvent to the manufacturers of cleaning solutions. The remaining product is refined and sold to gasoline blenders.

Supplemental revenues are derived from environmental recovery & tipping fees. Waste disposers can collect environmental recovery fees for the disposal of problem wastes and waste haulers pay tipping fees for the disposal of the waste polymers that they collect. These fees are normally paid to landfills. Polyflow expects to receive sufficient tipping fees for incoming polymer waste to result in a zero cost of incoming raw materials.

4.2 Petrochemical Markets

Styrene is a premium industrial chemical. The US market for styrene is roughly 6,000,000 tons with an average annual growth over 2.5% [1]. Polyflow Plant #1 will produce about 54,000 tons of styrene or less than 1% of the market requirement. This styrene will be sold to the major styrene suppliers and processors, who are now in discussion to make strategic investments in Polyflow. Polyflow's full cost for styrene is projected to be one-fifth of the traditional production costs. Polyflow’s styrene is projected to sell at market prices while offering to the customers, substantial value in significantly greater price stability than crude oil derived styrene.

Limonene is normally derived from citrus oil as a byproduct of orange juice manufacturing. It is a high value chemical increasingly being used as an environmentally friendly alternative to mineral oils and as a solvent for cleaning purposes, such as the removal of oil from machine parts and in household cleaners. It is more biodegradable than mineral oils. It is also a raw material for the synthesis of other chemical compounds and polymers. The 2006 world production was 86,000 tons [2]. A Polyflow dual-processor plant will produce 12,000 tons and have a significant impact on the market, resulting in market growth and taking share from the much larger 330,000 ton terpene market.

The high octane gasoline blend stock is always in demand to raise the octane of sub-octane grades of gasoline. The market is very large and a Polyflow plant will be a very small supplier and sell to gasoline blenders under yearly contracts.

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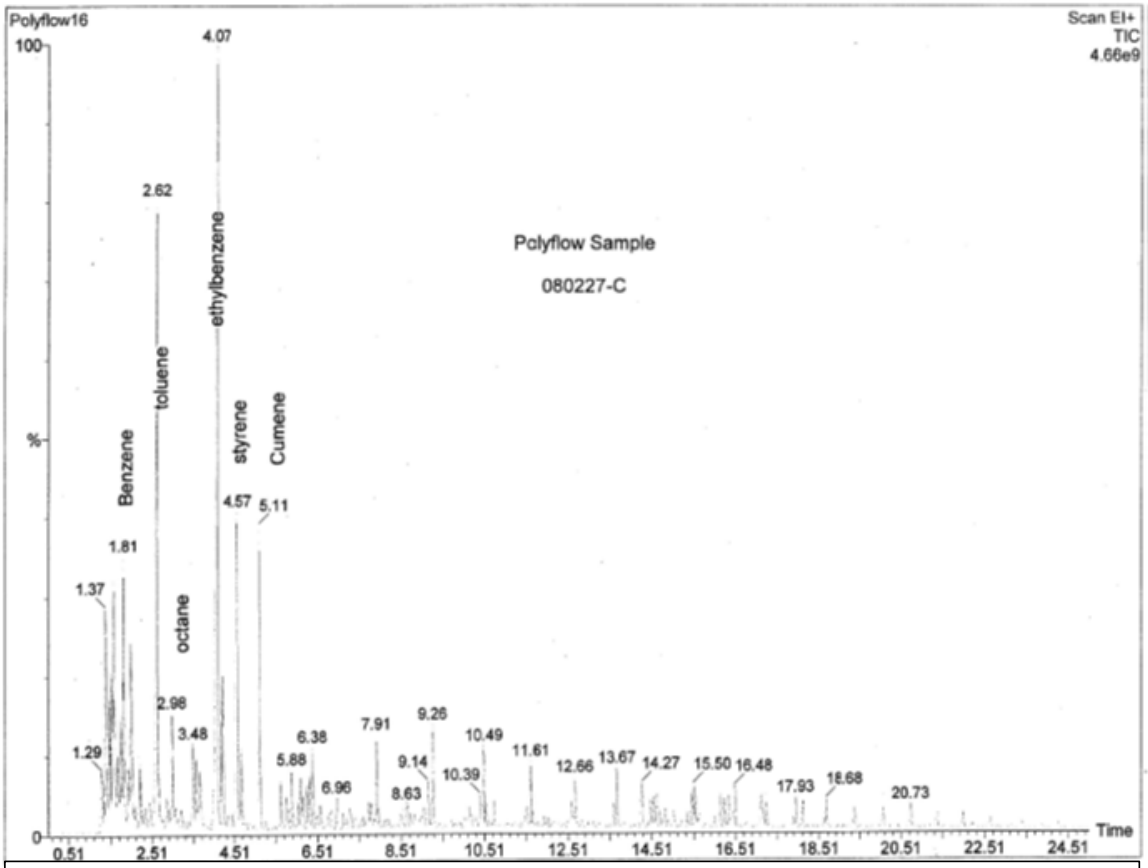

Figure 2: Gas chromatograph analysis of light hydrocarbon liquid product produced on Feb 27, 2008 from feedstock of 14% PE regrind and bucket liners, 5% shopping bags and miscellaneous film, 12% milk jugs and detergent bottles, 4% Tupperware, 13% supersacks, 3% butter tubs and food containers, 19% rejected PS molding compound, 10% tires, 5% PET bottles, 2% nylon carpet and the balance miscellaneous polymers and contaminants.

4.3 Feedstock

Because Polyflow's process takes mixed polymer waste it has overcome the weakness that traditional recyclers have in the short supply of clean, single polymer, feedstocks. Polyflow's feedstock is readily available in excess.

In the Cleveland/Akron area there is enough polymer waste [3] to feed five Polyflow processors. In addition to municipal polymer waste, there are also several segregated polymer waste streams suitable for the Polyflow process. These are end-of-life electronics, automobile shredder residue, carpet waste, powder paint waste and tires.

4.4 Plant Operations

A Polyflow plant will be a unique, small chemical plant consisting of solid polymer waste receiving and handling, Polyflow's patent pending thermal de-polymerization process and equipment, and product separation. A single processor plant will take 65,000 tons of polymer waste and produce 54,000 tons of liquid hydrocarbon products. The plant capacity can be doubled by adding a second Polyflow processor. Polyflow's feedstock is available in excess and will be received under contract from multiple sources. There is no need to accept hazardous wastes. Large feedstock like tires can be chopped and fed to the processor. The processor reduces the solid waste polymer to a liquid mix of monomers and solvents. Light non-condensable gas and char provide fuel to run the process with minimal supplemental fuel requirements. The liquid hydrocarbon product can be separated using common petrochemical industry distillations and extractions. Product can be gathered in storage tanks and shipped by rail and by tank truck. Polyflow plants will be designed with all necessary attention to safety and environmental controls as is required in any chemical plant.

5 THE MARKET DRIVERS

The Polyflow opportunity is market driven by the national need to reduce our dependence on foreign oil. Remaining oil reserves are increasingly located in the Middle East. The ability to increase oil production is in doubt. There are transportation and shipping risks. The

energy demand of China and India is forecast to double within the next fifty years. The recent energy crunches and price spikes highlight the need for improved energy security. Seven percent (7%) of our gas and oil is used to make polymers. Polyflow's process recovers the petroleum content of polymers.

Additionally, there is a drive to address global warming through the reduction of greenhouse gas emissions. There are on going projects to develop methods of carbon sequestration. The Polyflow process keeps the carbon in the polymer cycle and does not release it into the atmosphere. Polyflow makes plastic less energy intensive than glass and metals.

Polyflow addresses the concerns of environmental groups on the durability of polymer products, making polymers more recyclable than glass.

5.1 Market Size

The market for Polyflow plants is set by the market for the products (styrene at $6.0 Billion and gasoline at $360 Billion in the US alone) and the available polymer waste feedstock. Annually 35,000,000 tons of polymer wastes are generated in the US [4]. That is, in the US there is a market for over 500 Polyflow processors. 57% of the polymer waste is post consumer and commercial and 43% is post industrial. We estimate that over 50% is accessible and that with the increase in residential recycling, and with the advances in technology in the municipal recycling facilities, this amount is increasing. This results in a $13.5 Billion market. If we use the styrene market as the limiting market, the market size in the US is 222 Polyflow processors or 111 double processor plants like the Polyflow Plant #1 model. Since about half of the Polyflow product is styrene, the market for the products produced by the Polyflow plants in the US is $12 Billion.

5.2 Competition

The suppliers of the feedstock are the industrial sources, the recycling centers, and the waste haulers. All of these suppliers can increase their income by delivering the polymer waste to Polyflow. The competitors for the feed stock are the landfills and waste-to-energy plants. Polyflow offers to municipalities, low cost waste disposal and to the waste haulers, lower transportation costs and lower tipping fees than either of these competitors. Moreover, Polyflow eliminates the environmental negatives, and the resulting costs of landfills and waste to energy plants. Since plastic is 15% of the weight, but 30% of the volume, taking the plastic out of landfilled waste increases landfill life and profitability by thousands of dollar a day. Polyflow produces 70% less greenhouse gas than waste-to-energy plants that incinerate plastics.

Polyflow is a high value plastics recycling technology. Only about 6% of all polymer waste is recycled today [4]. That leaves 33 Million tons annually for Polyflow. Classical plastics recycling practices are limited to thermoplastics and the feedstock must be clean and sorted by type. Polyflow takes all polymers and takes them mixed. Classic plastics regrind is limited to a 20% mix with virgin material to maintain high properties. Polyflow makes virgin materials that can be used for 100% of the market. Moreover, styrene monomer sells for about the same or at a higher price than polystyrene regrind.

The competitors in the styrene market are the large petrochemical companies like BASF, Nova and Dow Chemicals. Polyflow is the low cost producer and the only producer with a local, stably priced raw material. For a $1000 product, Polyflow has the same processing costs of $200 and has a $750 to $800 raw material advantage over the major petrochemical companies. Because Polyflow is small, early customers will be carefully selected to be those that buy at least a portion of their requirements on the spot market to assure continuity of supply during Polyflow's start up.

6 DEVELOPMENT TEAM

Joseph D. Hensel, CEO. BS ChE., MBA Finance. An experienced entrepreneur and business manager including chemical process facilities. Experience includes executive management positions with Norton Company and Saint-Gobain Performance Plastics.

Charles Grispin, Inventor, Chief Technology Officer, BS Chemistry. Has significant knowledge and experience in the chemistry, physics, and engineering needed to recycle complex polymer compounds. Is the inventor of Polyflow's technology.

Alex Zold, Director, Experience in facility construction, logistics and the transportation industry, and in business negotiations. Experienced in the operations of a pyrolytic chemical processor.

Dr. Richard Schwarz, PhD Chemistry, Advisor. Experienced professional in new product development and commercialization.

Michael C. Dungan, Director, Vice President, Sales for Business Interiors and Environments, Inc. and Chairman of Entrepreneurs for Sustainability in Cleveland, Ohio.

6.2 Advisors and Support Team

Ira Kaplan, Benesh, Friedlander, Coplan, Aronoff, corporate legal advisor.

Eileen Mathews, BFCA, patent attorney

Calvin Cobb, petroleum industry strategic leader (ex. Invensys, Cap Gemini)

Dr. Frank Kelley, Dean Emeritus, College of Polymer Science and Engineering, UAkron

Rick Jordan, Past Director of the Solid Waste Association of North America

Rich Garcia, former CFO, Wastequip, Inc., the largest manufacturer of equipment for the waste industry

Phill Ashkettle, senior advisor at Falls River Group and past CEO of M.A. Hanna

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