Case 69

“Plow without a Plow”

This article introduces a creative approach to mixing liquids and gases as one of the 100 innovations that shape "The Blue Economy". This article is part of a broad effort to stimulate entrepreneurship, competitiveness and employment.

The Market

The world market for industrial mixing and blending equipment including maintenance and adjacent services was valued in 2010 at $120 billion. The need for blending liquids, fluids, solids, and gases is critical for a wide range of industries including food processing, plastics and composites, candles and waxes, tobacco products, cosmetics and personal care, glass, cement, ceramics, metals, inks, paints and coatings, drinks, pulp and paper, energy, water treatment, pharmaceuticals, minerals, oil and gas and agriculture. There are an estimated 150 manufacturers in the United States and 350 in Europe. The largest operators expanded to India and China. Whereas the capital expenditure has been sluggish over the past three years and is only now recovering to pre-2008 numbers, revenues from maintenance and spare parts is expected to have compensated the losses by 2011. Several of the leading corporations are century old family enterprises like Charles Ross & Son Company (New York, 1842), Possehl GmbH (Lübeck, Germany, 1847) which acquired the Farell Group established in Connecticut in 1848, Philadelphia Mixing Solutions (USA, 1909), and IKA Works GmbH (Germany, 1910).

The Innovation

The key challenge for blending and mixing is the time required to achieve a perfect distribution. This has lead to a rich field of research and development to design sophisticated mathematical models that can predictably blend a minute ingredient into a huge mass. Blending and mixing requires energy and space. The vortex (see Case 1) could blend in a few minutes minutes the active ingredients which otherwise require 45 minutes, increasing the potential output with the same equipment with factor 10, saving space and energy solely relying on the swirling movement of a geometrically induced shape. The oloid, a geometrical form developed by Paul Schatz in the early 20th century blends through its rotating movement oxygen into water requiring up to 80 percent less energy, undulating the interface between water and air, instead of pumping air with force into a water body. However, since speed and perfect distribution were considered inversely related, research should focus on changing this basic rule of the game. That is one of the approaches of The Blue Economy in order to steer business towards sustainability and higher profitability.

Angelo Mazzei managed equipment on his uncle's 10,000 acre vegetable farm and learned the ins and outs of crop irrigation and fertilization even though he obtained in 1968 a degree in automotive industrial technology from the California State University (Fresno). He started to experiment in order to render the mixing of a liquid fertilizer into irrigation water more efficient. When the California Aqueduct was built, irrigation water was delivered pressurized. This posed a problem for adding liquid fertilizer. By 1974 he had applied his insights in the venturi injector used for automotive exhausts to the blending mechanism for pressurized liquids and gases. The Venturi Effect is a jet effect: the speed of water increases as the cross section of the exit decreases. We all apply this concept created when we put our thumb on a garden hose to increase the pressure and the spray distance. While he worked as a salesman for John Deere tractors, Angelo perfected his injection and blending system to the point that he successfully filed for his first patent in 1978.

The Mazzei Injector captures pressurized water as it enters a narrow inlet and forces water towards the injection chamber. As the velocity of water increases, the pressure drops. To avoid the drag that is typically generated by cylindrical pipes, the pipes ideally take a conical shape, nearing the concept of the vortex (see Case 1 and 68). Through a suction port, liquids, fluids and gases can be introduced and mixed with water without the need for pumps. The blend can then be injected under pressure into the main pipe. This is how a car's tailpipe, applies the venturi logic. Pressurized exhaust gases from the combustion engine enter into the larger chamber, depressurizing, before leaving through a pipe into the atmosphere. Experience from the automotive sector translates to agriculture.

The First Cash Flow

Angelo's first commercial application permitted the blending of pressurized water with liquid fertilizers or nutrients, and supply the blend directly to the irrigation system. Adding air to irrigation water applying the same concept, increased the content of dissolved oxygen, which functions as a natural stimulant for plant growth. This lead to the invention of a new irrigation technique summarized in the trademark slogan "plow without a plow". The farmers realized that instead of tilling the land, blending air into the pressurized irrigation water would have the same effect with considerably less energy.

While Angelo was operating the first years of his start-up business in his garage with his wife Mary, the family went on to create Mazzei Injector Corporation and established themselves seven years later in Bakersfield, California. The company remains under family control expanding business through internal growth based on its growing patent portfolio. Starting from an exhaust pipe, simply using the laws of physics every engineering student learns from the 18th century Italian physicist Giovanni Batista Venturi, an impressive business niche emerged. Actually Angelo's invention is a platform technology that is applicable in dozens of sectors. The challenge is which ones to pick.

The Opportunity

The effects from applying physics offer straightforward and predictable results according to transparent mathematical models. Innovations based on this logic are the preferred technologies within the Blue Economy concept that lead to new business models. Mazzei went on to manufacture his devices and adapted his insights to dozens of applications, always using the same basic principles. Today, Mazzei equipment is sold in 100 countries around the world. The Mazzei Injectors are used to control microbial contamination, to disinfect food processing, and to control invasive species through a perfect blending of dissolved ozone.

In another smart application, the Mazzei injectors and mixing devices capture the energy created by the flow of water, and use it to produce ozone from the water itself, and then mix it into the same water stream. This Mazzei equipment degasses all undissolved gas bubbles. Everything is produced and consumed in the one process starting from water, without ever releasing any greenhouse gas into the atmosphere or consuming additional electricity. Using what you have (energy from the flow and oxygen for disinfection extracted from the water) is one of the core principles of the Blue Economy. This technology compares well with the chlorine destruction system (see Case 42) which is also powered by the flow of water.

By now Mazzei has 14 patents. The applications of this purely mathematic formula based on geometric forms are stretching from mixing systems for fire retardants, water aspirators creating a vacuum using tap water pressure and atomizers to spray paint, nozzles for fire extinguishers, wine aerators, filtration systems for aquaria, automatic pool cleaners, compressed air vacuum cleaners, scrubbers of flue gas, sand blasters, scuba diving regulators and masks for oxygen therapy. It seems that this technology has barely started to find its inroads into our daily lives. The Mazzei group is committed to keep the research pipeline full of new ideas and fresh approaches. This is where the entrepreneurs are in high demand to exploit this platform to create effective solutions for society.

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… Further information on the 100 innovations at www.theblueeconomy.org.