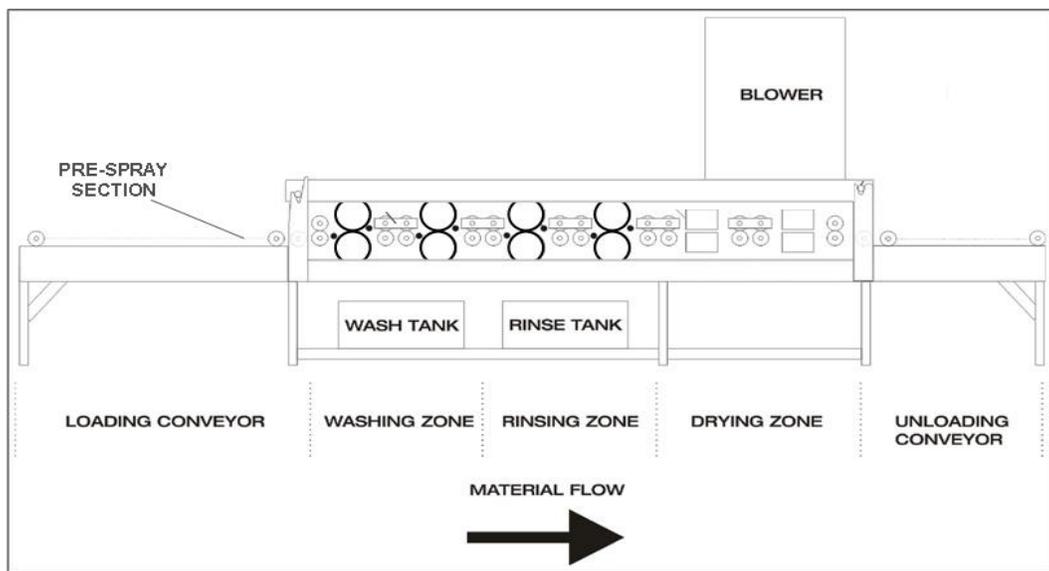


GLASS WASHING: A HISTORY OF FLAT GLASS WASHING EQUIPMENT

Written by: Bob Lang, Solution Specialist at Billco Manufacturing

Flat Glass Washing Equipment is defined in this discussion as meaning a horizontal roller, conveyor-type machine, with several pairs of top and bottom cylinder-type brushes mounted between the rollers. These machines include a drying section consisting of round or rectangular tubes, also mounted between the conveyor rolls, which obtain air from a centrifugal blower. Vertical washing machines will also be discussed later.



The Beginning Years and Suppliers:

Starting in the mid-1930's, the flat glass industry began to offer new products that were more sophisticated than ordinary window glass, as well as began to automate the processes of some existing products. I am speaking mainly of the invention of laminated glass, and the automation of the mirror silvering process. Although insulating glass was invented in the 1930's, it did not gain much use until the 1950's.

Some of the companies producing mirrors built their own machinery. However, there were two companies in the 30's and 40's building mirror production lines (also referred to as silvering lines). They were Henry G. Lange Co., and Sommer and Maca, both of Chicago. A glass cleaning machine was part of

these mirror lines, and should probably be considered as the first commercially produced glass cleaning machines. The glass cleaning machines used in mirror lines were quite extensive, consisting of three cleaning sections:

- Multiple banks of felt pads that rotated and oscillated, using rouge as the medium, were used for actually polishing the glass surface.
- Multiple banks of cup-type brushes that oscillated and rotated, using cerium or detergent as the medium, were responsible for removing the rouge and other debris.
- And finally, several cylinder brushes using water as the medium for final cleaning.

In the 1940's, the above mentioned companies appear to be the only companies building glass washing machines commercially. PPG, and at least one British company, were making laminated auto glass in the 1930's. It is suspected there were building their own glass cleaning machines to meet their needs during that period, or they were hand cleaning the glass.

By the early 1950's two more companies began building glass washing machines. They were Century Engineering, and Billco Manufacturing. Century built mirror lines, as well as machines for cleaning other flat sheet products.

Billco's Beginnings in the Glass Washing Machinery Business:

Billco records from the early 1950s show that they were building glass washing machines in widths from 14" to 48", for cleaning glass for tempering, as well as for cleaning small parts for gauge faces, clocks, laboratory slides, and appliance glass panels. A 14" wide washer for cleaning slides and other small parts is shown below in Exhibit B.



Exhibit B

Series 100, 14" (356 mm) wide "FlipTop" Glass Washer with eight (8) brushes.

Interestingly, in 1955 Billco sold a 48" wide washer to Hordis Bros. Co. for cleaning glass prior to tempering. At that time, there were horizontal-continuous, and vertical-type tempering furnaces. This washer for Hordis (an example is shown in Exhibit C below), was for cleaning glass prior to a horizontal tempering furnace, and appears to be the first one that we built for that purpose.

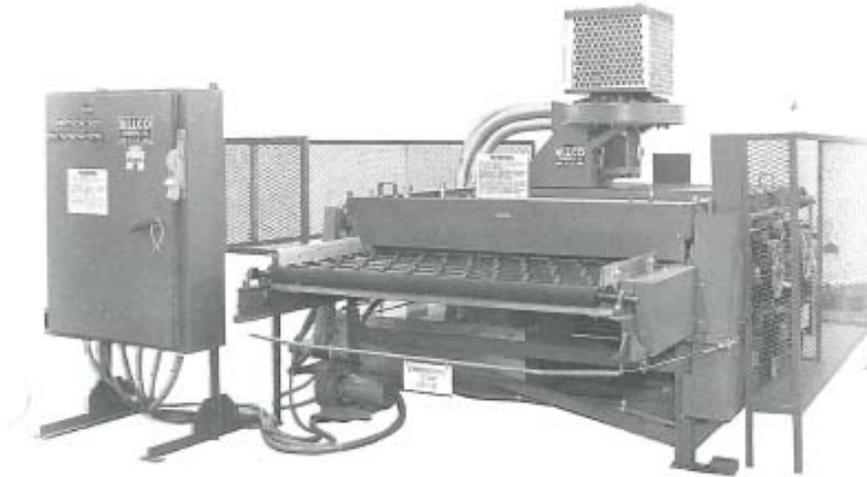


Exhibit C

Early tempering furnaces were problematic for glass washing machines, because the glass was not always flat. I will always remember an interesting revelation from my first, solo field installation of an 84" glass washing machine. This machine was to be installed prior to a production line for manufacturing insulating glass units. The tempered patio doors that the company brought to me for cleaning from their brand new in-house tempering line, had bows of 1" or more. Being a novice, I just assumed that somehow I had to make our washer clean that glass. After several hours of frustration, and a call back to Billco, I had to delicately explain to the company managers that neither our machine, nor anyone else's, could pass their bowed glass through a flat glass washer. It was quite a learning experience for a young guy just entering the glass industry... and probably likewise for the operators of the tempering line.

Insulated Glass Unit Manufacturing Becomes a Factor:

By the mid-to-late 1950's, Billco was beginning to build significant numbers of glass cleaning machines for producers of insulating glass units. These machines were 60", 72", and 84" wide, and mainly with 4 pairs of brushes and two pairs of air knives. The reason for the 84" wide machines was primarily so that 34" x 76" patio doors could be processed in the wide dimension, making it easier for two people to handle the door panels as they exited the washer and entered the clean room. A typical 84" glass washing machine from that era is shown on the next page in Exhibit D.



Exhibit D

**Series 600, 84" wide (2134 mm) "FlipTop"
Glass Washer with eight (8) brushes.**

De-mineralized Rinse Water:

In 1958 Billco got its first exposure to what 30 years later would become a very important requirement for glass washing machines, the use of treated, mineral-free water (De-ionized or Reverse Osmosis). During an installation of an 84" wide glass washing machine for cleaning glass prior to producing insulating glass in a mid-Ohio window manufacturing company, we found that we could not eliminate a white, chalky residue on the glass as the glass exited the washer. After discussions with water experts, we learned that the residue was of a very high content of calcium and magnesium minerals in the water, which had evaporated on the glass during the drying process. Only after installing Deionization tanks from Culligan, to supply mineral-free water to the final rinse, were we able to eliminate the residue. This requirement became a life-saver for companies who were using glass washing machines in a roughly defined belt across the United States, from Boston to Phoenix, where ground water generally has a high content of calcium and magnesium.

Successes and Advancements during the 1960's and 70's:

In the 1960's and 1970's, many hundreds of glass washing machines were built and sold for cleaning glass prior to tempering, insulating, and laminating. In the 70's, Billco was concerned that the flood of business would surely slow down, but it did not. Manufacturers began installing their own insulating glass unit manufacturing lines in order to gain better quality control over their products. This same phenomenon happened with washers for tempering operations in the 1980's and 90's.

Throughout the 1960s and 1970s, the primary washing goal to produce glass that was visibly clean, with no water on the edges. Some washer manufacturers were better at producing dry glass than others, mainly because of the design of their drying systems. Those that were successful were able to use room temperature rinse water, while others had to use heated rinse water. The heated rinse water was much more expensive and also caused spotting problems due to the evaporation of the water, resulting with mineral residue on the glass.

Maintenance saving features were also stressed. All early washers had to be partially disassembled in order to reach any broken glass inside the machine, or inspect and/or replace rollers or brushes. In early 1960, Billco introduced a patented feature in their washers, called a “Flip-Top” (shown below with the top in the up position). This feature allowed access to the internal parts of the machine in a few minutes, and proved to be enormously successful for Billco’s glass washer sales.



Exhibit E

Glass packaging techniques also influenced glass washing machine designs. For the first few decades, glass was mainly interleaved with sawdust and/or paper in shipping cases. One problem with paper was that if the shipping case was exposed to moisture or radical variances in temperature, chemicals could leach out of the paper and stain the glass. Many times these stains could not be removed from the glass surface in a glass washing machine. Glass producers developed two significant changes in their packaging technology that eliminated these problems. First, they eliminated the paper and sawdust, in favor of plastic (Lucite) beads. Next, they began spraying slightly acidic chemicals on the glass that deterred staining.

Depending upon the quantity of these beads on the glass, some manufacturers required a pre-spray section to be added to the front of a glass washer. This section was primarily responsible for ridding the

glass of packaging material in order to prevent contamination of the downstream sections of the washer. Eventually, the pre-spray section became a requirement in almost all glass washing machines. You can see a pre-spray section mounted at the front of the machine shown in Exhibit E).

Vacuum Coating on Glass Changes Glass Cleaning Technology:

The years 1973-74 were a watershed moment in glass washer technology. This was the time period that the company Airco Solar Products (a division of Airco-Temescal), introduced their large area magnetron sputtering deposition coating lines, for applying soft coat, low-e coatings on glass. This changed glass washer requirements from that time forward.

To properly clean the new soft coated glass, visibly clean and dry glass was no longer good enough. The glass had to be chemically clean. If the glass surface to be coated had any traces of minerals, or other debris, there would be minute pinholes in the coating, which would cause the glass to be rejected. This meant that the glass surfaces had to be vigorously scrubbed, then washed and rinsed some more, then rinsed with mineral free water, and finally completely dried.

The glass cleaning machines that were used on the vacuum coating lines had some similarity to those supplied on mirror lines. They included pre-wash sections, banks of oscillating / rotating cup-type brushes, multiple pairs of cylinder brushes, and very effective drying systems. As this industry has advanced, and more coating lines have been installed, almost every coated glass manufacturer has their own specifications for how their glass washing machines are to be configured.

Another change was the type of customers that were specifying the washing machines, and monitoring the cleaning processes on the coating lines. Up until this time, a glass washer supplier was dealing primarily with owners, maintenance, and production personnel from a customer's facility. These people may or may not have been engineers. The fabricators relied mainly on the knowledge and expertise of the glass washer manufacturer to produce the visibly clean and dry glass they needed to temper, laminate, and fabricate insulated glass units. In the glass coating business, we were dealing primarily with mechanical, electrical, and chemical engineers. Many of these engineers were from other industries such as the electronics industry. They already had very specific ideas about how they wanted the cleaning equipment to look and perform, and they had in-house laboratories to test the glass surface to make sure it was clean enough to accept a coating.

The glass fabricator that received the coated glass that was produced on the vacuum coating lines also had new challenges. The fabricator had to handle the glass in a very particular and careful way, so as not to damage the coating on the glass. Therefore, the glass washers they required had to be specially equipped to process the coated glass prior to using it in their tempering or insulating unit manufacturing lines. This led to the requirement of softer than normal brush bristles, pre-spray sections, higher wash water temperatures, and the use of a mineral free final rinse in their glass washers. It didn't necessarily mean that they had to scrap the glass washers they already were using, but it did mean they had to have those washers modified with the above mentioned new features.

In this same time period, there was another glass coating process developed where the coating was applied on the glass during the float glass manufacturing process. This was referred to as a pyrolytic coating. These coatings were harder than the vacuum deposition coatings, and generally did not require the delicate handling required by the soft coatings. In general, the standard glass washers were suitable for cleaning these pyrolytic coatings. However the producers of this pyrolytic coated glass did recommend the use of pre-sprays and mineral free rinse water.

High Performance Coatings Increase Glass Cleanliness Requirements:

As the vacuum deposition coating technology advanced, some of the coatings have become extremely delicate, and therefore require much more careful handling and processing. In order to make sure their customers were handling and processing their coated glass products properly, the coated glass suppliers have introduced special programs that end users must follow in order to use the coated glass. One requirement of the programs was that the fabricator must have a properly equipped glass washer for processing the coated glass. They also have requirements for maintaining the glass washer. This has actually been a good thing for the entire industry, because it has improved the quality of the final glass product, as well as maintaining the glass washer at a much higher standard than had been maintained in the past. It has increased awareness by glass washer users that in order for them to achieve clean glass from their washing machines, they must keep the machine clean and well maintained.

The changes to washing machines and their maintenance brought on by the coating industry have also crept over to washing machines being produced for all other glass processes. Glass washer manufacturers in general are recommending better equipped machines, no matter what the end glass use is, as well as recommending much more thorough maintenance programs. An example of a washer for coated glass is shown in Exhibit F.

Exhibit F



The Solar Panel Industry Comes On-line:

One other industry that has affected the history of glass washing technology is the solar panel industry. The washing machines used for cleaning most solar panel cover plates are similar to standard glass industry washers. However, the cleanliness requirements for glass coming out of the washer prior to applying their thin film coatings are every bit as stringent as for the vacuum coating industry. Thus, they require very extensive cleaning and drying systems. A washer for the solar panel industry is shown Exhibit G.



Exhibit G

Current Glass Washing Machine Technology:

Over the past two decades, standard flat glass washing machines have maintained their historic configuration of a conveyor bed of rollers, multiple cylinder brushes, and air knives positioned between the rollers at various locations. However, there have been many additions to the washer to improve on sustaining a washer's cleaning capability, reduction in water and chemical resources, reduction in cost of ownership, and overall easier maintainability for the user. Available options and advancements in glass washing technology are endless, with the most common additions being:

- Sound reduction packages well below 90 dBA sound level.
- Spray sections prior to brushing the surface have become standard for almost all applications.
- Four-corner, top-section lift systems for accessing the interior of the machine.
- Minimal water use within each washer section by use of straining filtration and water conditioning systems.
- Process control and monitoring options, such as tank level control, solution dosing systems, and water quality monitoring.
- Diagnostic feedback to the user through touch screen interface, alerting user of warnings and machine fault conditions.
- Basic and advanced sequence control for stand-alone and inline glass washers.
- Low-e coating detection systems.

Vertical Glass Washing Machines:

Another type of glass washing machine that must be included in this discussion is the vertical washer. These machines have similar configurations to horizontal washers, however the machine was designed to stand on end and tilted at about a 9° angle. These vertical machines first were used at the end of vertical glass edging machines. Generally, they had only one or two pairs of brushes, and one pair of air knives. They were typically sold by the manufacturers of the glass edging equipment. However, starting in the 1960's in Europe, some equipment manufacturers started selling and exporting vertical washers to glass shops for any cleaning application. Although they did produce visibly clean glass, it was never at the production level or quality of a horizontal washer with multiple brushes and air knives. In the 1970's, more sophisticated vertical washers were designed and sold by both European and US manufacturers, specifically for high-production vertical insulating glass manufacturing lines.

The Future – Where is flat glass cleaning technology heading?

Over the years, there have been conveyor-type washing and drying machines that have been designed without brushes, consisting of only high and low pressure sprays with a drying section. The purpose of this design is to clean glass and other materials that were either too fragile, or had a coating that could not withstand the vigorous brushing of a standard washer. These machines are fine for their design purpose, but will not remove the debris found on standard float glass, and therefore not widely used.

More recently, there are conveyor-type cleaning/drying machines being built to clean non- flat glass parts, using ultrasonic sound waves. Again, these machines are great for their design purpose, but although it might be possible to design such a machine for normal flat glass cleaning requirements, it's cost and length would be out of the question for the production needs of today's glass fabricators.

At this point in time, when considering the efficiency and cost of a standard glass washing machine design, a comparable cleaning technology has not yet been developed. However, one must never say never. Glass washer manufacturers and specialty glass fabricators are constantly investigating cleaning alternatives.