Heatsealing – Art or Science

Reduce Cost and Increase Profit with Precision Heatsealing

Follow the evolution of heat sealing plastics that began with the development of the thermoplastic materials themselves. And how the industry has changed with precision and repeatability.

Perfect Seals... Every Time

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Is Heatsealing Plastic Materials – Art or Science?

In recent years the methods and means of cutting and/or sealing plastic films and joining plastic components has advanced from an art to a science by the development and introduction of process controls that virtually guarantee perfect bonding every time. The development of this capability has been driven by the demand for plastic packaging materials in critical applications, especially in the life sciences, where validation is required and failure is not acceptable. In addition, it has been shown that precision processing virtually eliminates the possibility of product rejection; thereby reducing costs and increasing quality and profit margins. It naturally follows that the use of precision process controls in all applications can significantly reduce cost by making perfect products and sealing perfect packages with virtually no scrap or wasted time.

The investment in precision heat-sealing equipment is recovered time and time again by minimizing down time, eliminating costly machine repairs, reducing power consumption, increasing productivity and minimizing material waste. This is especially important in the case of the newer polymeric materials that are increasingly more expensive.

In addition, new polymeric materials are constantly being developed with qualities that expand their usefulness. However, the improved quality and performance of these materials often comes with increased cost and the need for precise control to assure consistently perfect fabrication. It is, therefore, all the more important to eliminate the possibility of rejects and the waste of these materials.

Evolution of Heatsealing Perfection

The art of heat-sealing plastic materials began more or less concurrently with the development of the thermoplastic materials themselves. Plastic materials would have much less utility and commercial value if they could not be sealed or joined efficiently.

Initially, the sealing of materials was accomplished by manual means with simple hot wands or seal-bars. When sealed manually, the timing and the quality of the seal was inconsistent and dependent upon the skill of the operator. In addition, the seals were still hot when the sealing means was removed. Because heat-seals on plastic materials are not firmly bonded until the seal is cooled, the integrity of the seal was dependent upon "hot tack", the ability of the film layers to adhere to each other while still hot from the sealing process. Plastic films were modified to increase their "hot-tack" qualities. This increased the cost of the film but did not necessarily improve the ultimate seal strength. In the meantime, it was critically important to handle the warm film with great care to avoid damage to the integrity or appearance of the seal.

Prior to the introduction of Impulse Sealing Machines, sealing was accomplished by machines that were fitted with "hot bars" or "hot platens". Hot bars and platens are still in use for applications where cooling control is not as critical to a specific application.

Plastic sealing machines with "hot bars" use sealing bars that are constantly heated with cartridge heaters that are positioned within the bar as carefully as possible to deliver uniform heating to the sealing surface of the bars. Thermocouples or RTD's are also positioned as skillfully as possible to monitor and control the temperature of the bar. In spite of the best efforts to exercise accurate temperature control, the temperature of the constantly heated bar or platen varies from place to place and will fluctuate because of the delayed response of the thermocouples and the still further delay in re-heating the sealing member to the required sealing temperature. The result is the fluctuation of the bar or platen temperature followed by substantial cooling when the bar contacts the work piece. This is particularly noticeable when trying to increase the production rate because of the time required to re-heat the sealing member at every cycle.

In spite of these limitations, constantly heated bars and platens are useful in applications where the speed of the machine and the nature of the materials to be sealed offer a wide window of thermal opportunity.

Some plastic film materials have a wide temperature range of seal-ability and will seal successfully in spite of a wide variation in sealing temperatures. However, many films do not offer a wide tolerance in the sealing temperature range. Most operations that seal or assemble plastic materials cannot afford the risk and attendant cost of creating defective products caused by a lack of time and temperature control. This is particularly true in packaging for healthcare, food, and precious or noxious materials.

In the mid 1940's "Impulse Heat Sealing" was introduced into the market by the Vertrod Corporation. This was an important contribution to the art of heat sealing because it provided the opportunity to provide a momentary pulse of power through a relatively thin heating element that was pressed against two or more layers of plastic film. The energy supplied to the band produced enough heat to join the materials and the jaws could remain closed long enough for the seal band to cool and create an acceptable seal. The impulse sealing technique gradually gained acceptance and earned a significant share of the market, especially for sealing polyethylene and similar products.

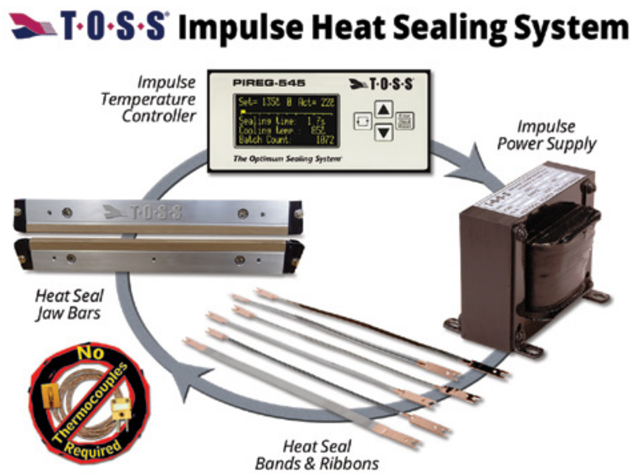
Early impulse heat-sealing machines could only be controlled by setting the voltage that is applied to the heatseal band and setting the timing of the sealing cycle. On manually operated machines, the duration of each cycle was determined from cycle to cycle by the skill of the operator. With the advent of automatic or semi-automatic machines, the attention of a skilled operator was still required because the temperature of the sealing band and bars became gradually warmer with every cycle.

When an equal amount of energy is added to the sealing member with each additional cycle, the sealing temperature gradually rises and ultimately becomes too hot. Therefore, it must be frequently adjusted to avoid overheating. In addition, an uncontrolled heat seal band will overheat if energy is applied to the band before the jaws are closed. This limitation creates two problems. If the sealing bars are closed before the sealing band is heated, the heatseal band will be restrained and will not be able to expand freely when the band is heated. Also, the physical stress within the band when combined with the thermal stress will cause band distortion and a defective seal as well as premature band breakage. The inability to preheat the band to a controlled temperature before jaw closure prolongs the sealing cycle time and thereby reduces productivity.

Several arrangements were tried in an attempt to automatically adjust or compensate for these limitations but none of these are totally satisfactory. Nonetheless, the first steps had been taken to advance heat-sealing technology to become less an "art" and more a "science".

T·O·S·S Technology

In the 1970's, TOSS GmbH, in Germany, recognized the need for a high response temperature control system. The system would have to constantly monitor the temperature of the heatseal band, raise its temperature to a predetermined set-point in milliseconds, and hold it at a precise set-point for a predetermined sealing time to allow the seal to bond and cool.



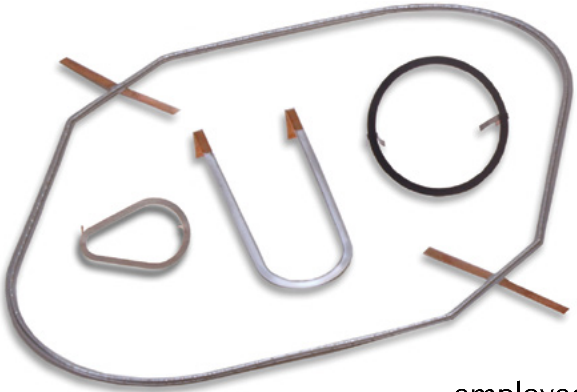
The new system also required a unique alloy that would replace the old nichrome heatseal bands. TOSS Alloy-20,® was then introduced. This new alloy was able to predictably and measurably change its electrical resistance as a function of its temperature. An ultra-high response controller could then be used to monitor the actual temperature of the heatseal band by monitoring the change of its resistance. The controller could then automatically adjust the power supplied to the heatseal-band in conformance to a preset program. Previous attempts to accomplish this degree of control by using thermocouples or RTD's failed because the sensors could only monitor the temperature at a single location and were far too slow to respond.

In addition, electrical components like transformers and current transformers that could predictably respond to signals generated by the controller were also needed. The coordination of this family of related components, together with special heatseal bands, heatseal bars and bar facing materials, form the complete system known as TOSS Technology.

This total system called TOSS Technology was globally introduced by TOSS GmbH in Germany and TOSS Machine Components in the USA for the impulse heat-sealing of polymeric materials. TOSS Technology is the systematic application of the various elements required to predictably produce ***"Perfect Seals... Every Time"***.

TOSS Alloy-20® Heat-Seal Bands

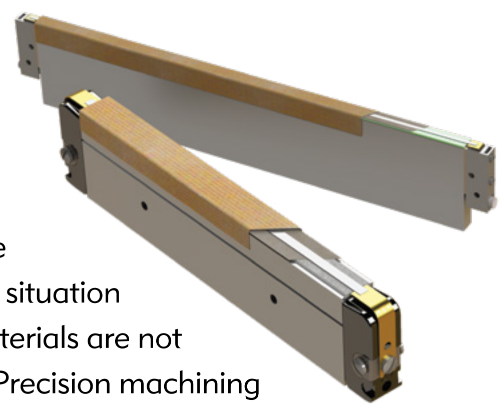
It is absolutely essential that an alloy material used for the heat sealing element be durable and formable into the different shapes required for sealing and cutting. Whereas nichrome heat sealing bands were originally used because of their high electrical resistance, they are soft, less durable, and will not hold their shape when formed into the various configurations that are employed in the current "state of the art". The TOSS companies introduced TOSS Alloy-20 heatseal bands that are stronger and last longer in service, as well. To achieve optimized precision sealing of plastic materials it is important to select a heatseal band configuration that is most suitable for the task at hand. Scientifically designed heatseal bands are available from the TOSS companies in over 300 different sizes and shapes. When selecting a band, the width is usually determined by the nature of the application. The thickness, however, is more often related to the nature of the film or object to be sealed. Thicker bands, greater than 0.2mm, will heat-up and cool-down slower but they are more durable and, when pre-heated, they will store more heat to be delivered to the work piece and thereby accelerate the sealing cycle. Thicker films, greater than 6mil or thick fitment flanges will seal better by using a thicker band. In the case of thin materials, a thinner band, less than 0.2mm, will heat and cool more rapidly thus allowing a higher production rate.



Cutting wires or cut-seal bands are also available to cut and seal between adjacent packages or seal the edges of films while concurrently cutting away an adjacent part or scrap material. When cutting plastic materials, special bands are employed that are constructed with a raised bead that is heated at a slightly higher temperature than the adjacent portion of the heatseal band that creates a seal of the desired width. Standard bands are available in a variety of sizes. In addition, custom made bands can be made to produce ideal performance on specific plastic film compositions and thicknesses. Contoured bands are also available to cut curves, rounds, ovals, or irregular shapes for products like gloves or protective garments.

Heat-Seal Bars

Heat-seals can be made in various lengths and configurations. This presents the next challenge because the perfect seal must be uniform throughout its entire length whether it is inches or several feet. There is a need for absolutely uniformity of force applied to the full length of the seal.



In the course of working through hundreds of applications it became clear that the best heatseal jaw bars are aluminum bars with a generous cross-section. Because a perfect seal is not accomplished until the seal is cool, it is helpful to use massive jaw bars with a high specific heat so that the bars can absorb the residual heat during the cooling cycle. In the case of short bars this is not a problem because the bars can be machined to be flat and true. Long bars present a different situation because, in spite of best efforts, the commercial tolerances of stock materials are not sufficiently accurate to assure the precision required for uniform force. Precision machining of long bars is also more difficult. The TOSS companies have resolved this issue by having their aluminum jaw bars custom extruded to the closer tolerances required. In addition, a relieved area on the contact face of the jaw bar is provided to receive a self adhesive silicone rubber facing. The TOSS jaw bar is also designed to receive specially designed, insulated, and spring loaded, Jaw End Blocks that automatically assure that the heatseal band is properly positioned and tensioned when an original or replacement heatseal band is installed.

Now, using the available scientific technology, one can achieve a precise, predictable seal or cut every time using a self regulating system and leaving very little to chance. What was “art” is now “science.”

PackworldUSA

With T·O·S·S® Technology

The Optimum Sealing System®

As the application of TOSS Technology gradually unfolded, more and more custom packaging machine builders adapted the TOSS system to assure the performance of their machines. The value of enhanced precision became apparent. This created a demand for a standard line of heatsealing machines using TOSS Technology exclusively. In 1995, PackworldUSA was founded in response to this demand. PackworldUSA entered the market to produce heat-sealing machines with the philosophy that precision, quality, and durability are the highest priorities. This philosophy has proven to be successful. The value of PackworldUSA machines was first recognized by the health-care and life sciences companies where perfection and process validation is essential.

Other industries soon recognized that durable precision heat-sealing machines quickly earn their keep by making ***Perfect Seals... Every Time***

To obtain more information about TOSS Technology

request a FREE 48-page booklet.

"9 STEPS TO HEATSEALING PERFECTION"

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