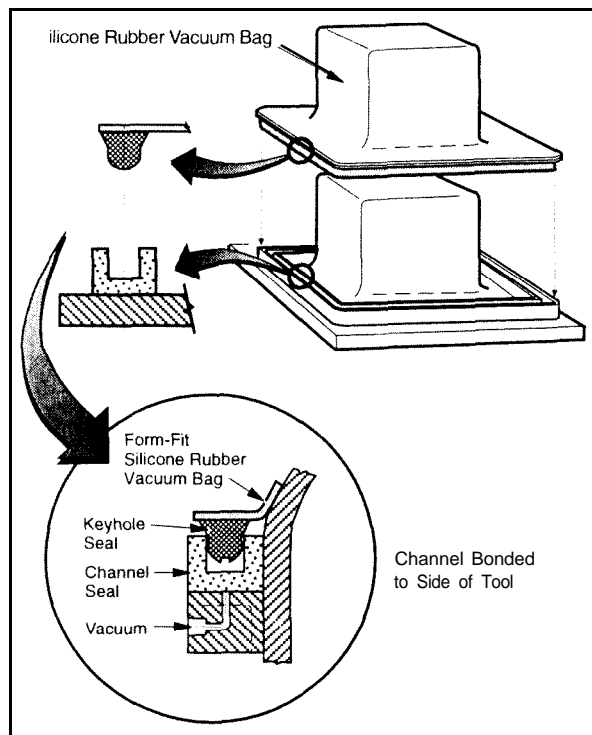


Reusable Vacuum Bagging Device for Producing Composite Parts

Cosby Newsom
Bondline Products

A device provides for a reusable vacuum bag process to fabricate composite parts used in the aircraft and other industries. The process reduces the cost of labor for each part produced.



Reusable Vacuum Bagging Device

Introduction

Current practice in manufacturing composite parts involves placing continuous-filament or woven-fabric lamina over a mold to shape the part. A thermoset resin is then coated over the lamina. For high-performance parts, such as those used in aircraft, it is not uncommon to build up, coat by coat, up to twenty layers of lamina.

The lamina in each coat is laid up, layer by layer, according to design specifications. Any voids or air bubbles between layers can cause the part to delaminate under stress. Thus, a sheet of silicone rubber or high-performance plastic film is usually placed on the part, and a vacuum is used to squeeze out the voids and air bubbles after every few layers are laid up. The manufacturing cost is increased because the rubber sheet or film is usually discarded after just one use.

Bondline's improved process represents the first change in this manufacturing process in 40 years. Up till now, a large amount of the material had to be discarded with each cure. Sealing the thin film to the sticky tape had to be done by hand, and the leaks that could form during cure often meant the part had to be rejected. An added problem has been with wrinkling in the rubber sheet or film, which complicates the heat-flow process over some areas of the part.

Concept Description

Bondline's patented auto-vat keyhole and channel seal works like an ordinary valve (see figure). An airtight, separable joint is formed between the channel, which is bonded to the tool base and the keyhole, which is bonded to the flexible, silicone rubber diaphragm. This allows for rapid assembly of an airtight membrane over the layers of composite materials. The layers are compressed

against the tooling and cured under even heat and pressure to form the part, eliminating any problem of wrinkling.

A typical valve consists of a seat and a disc, which are brought together as two matching cylinders. In Bondline's auto-vat keyhole and channel system, the channel acts like the seat and is bonded in a continuous loop around the edges of the tool. The keyhole acts like the disc and is bonded to the diaphragm in a matching loop, which is pressed into the channel to form the seal between the two.

Vacuum within the channel pulls the keyhole into it. This vacuum also pulls the sides of the channel tight against the keyhole. The two elements can withstand continuous temperatures of 177°C, even surges to 204°C. At those temperatures, the silicone rubber expands, which reinforces the seal and enables the keyhole to mate and seal with metal grooves.

No cleanup is needed after cure, the keyhole and channel seals are separated, and the part is removed without generating any scrap material or requiring any extra manhours. The tooling is then ready to go again.

Economics and Market Potential

The reusable vacuum bag allows the same silicone form to be reused for

over 100 parts, reducing both material and labor costs. Typically, cost savings are 40% or greater per part, depending on the size of the production run. The quality of the production line is enhanced because more consistent parts are produced in the process. The small vacuum pump used in the process costs <\$300.

The vacuum bag fabrication process is widely used in the aircraft, aerospace, military, automobile, marine, and recreation industries; a market of >\$1 billion per year is estimated. One user, Elmwood Sensors of California, installed the reusable vacuum bagging system on its cauls and mounted three each in two baker's racks. The systems slid out of the rack one at a time for loading and unloading, and the racks were easily rolled into the oven for cure, saving at least two-thirds floor space in the process. In addition, the company not only reduced its manpower, but saved a considerable amount of money in initial investment and follow-up cleanup costs.

Key Experimental Results

Bondline tested different shapes to form the seal: by applying vacuum, measuring the vacuum, and then shutting it off to check the leak rate at room temperature. Approximately eight different types of seal mechanisms were built and then tested for leak rate at 177°C up to 204°C. in

determining that the valve-like design, the keyhole/channel seal, worked.

Future Development Needs

The invention is available for license to other manufacturers who can build their own reusable vacuum systems under license, or it can be incorporated into specialized production equipment by Bondline. The invention is being spun off into other specialized uses, such as the autoclave alternate device for producing tubular-shaped composites. at significantly reduced cost.

Transfer of this technology is available via instructional video tapes; in-plant, hands-on instruction; or licensed use of methods.

For more information, contact

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