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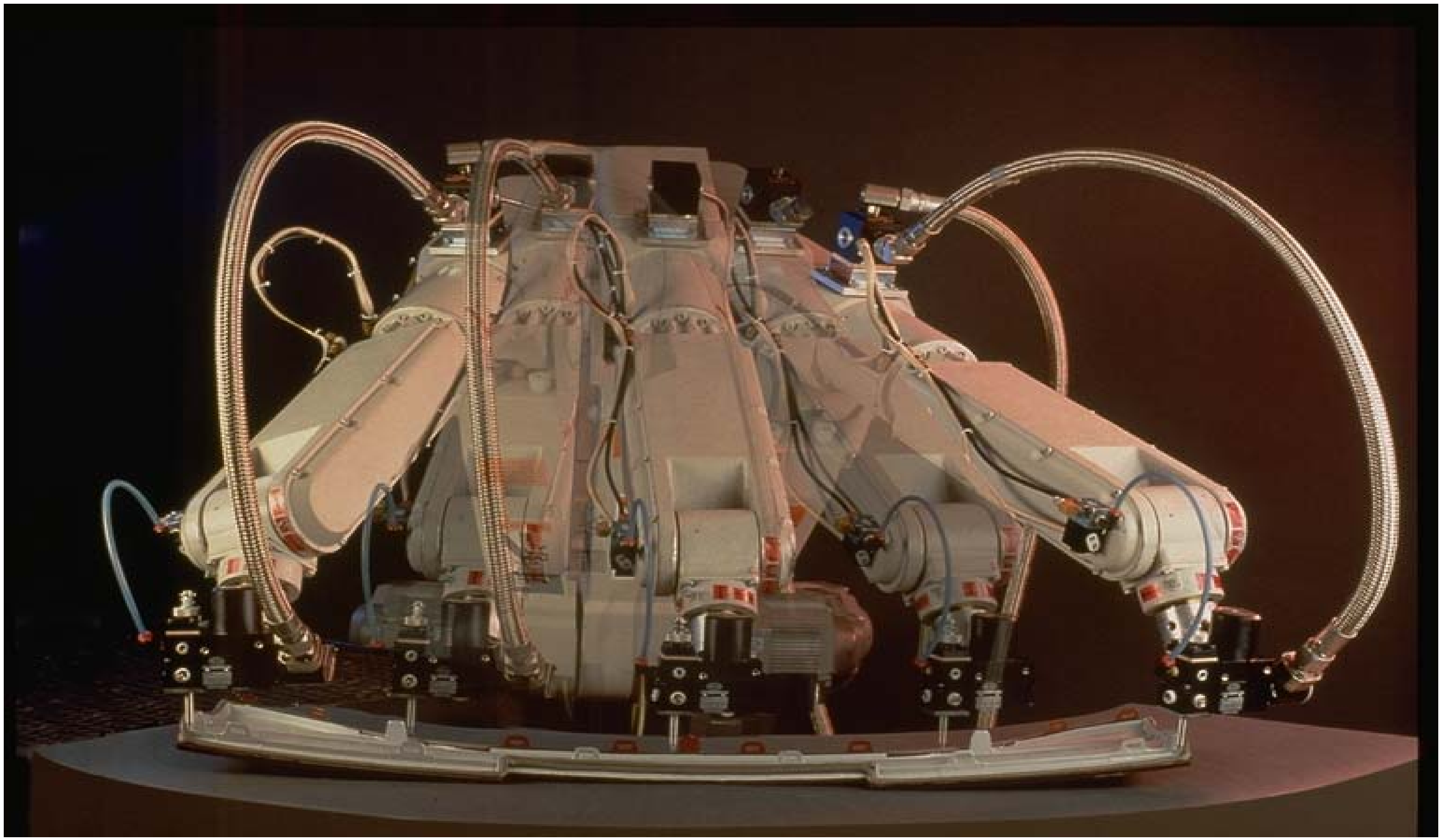
Dispensable Gasketing and Sealing Materials for Manufacturing



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Dispensable
Gasketing and Sealing

Engineers are constantly faced with the challenges of sealing assemblies against air, dust, noise, and making sure that these assemblies do not squeak and / or rattle.

Commonly used methods have always included preformed rubber or molded gaskets, die-cut adhesive backed foams and tapes, and a myriad of extruded or molded sealing devices.

Automated gasketing and sealing systems that utilize dispensable materials are emerging as a cost effective alternative for many of these labor intensive traditional forms of gasketing and sealing.

Gaskets and Sealants Definitions

- **Gaskets:**
- Gaskets are sealers that are in assemblies that require a seal still be achievable after the item will be be taken apart and put back together. A gasket must still supply a seal after being reassembled
- Serves as a barrier to prevent the ingress or egress of various materials.
- Gaskets are often referred to as serviceable when they can be take apart and put back together.

- **Sealants:**
- Sealants are materials that are for one time use only. Meaning, the whole assembly is replaced or the particular area that needs to be sealed will not be taken apart and put back together as part of its requirements.
- Prevents excessive absorption of adhesive or penetration of liquid or gaseous substances.

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Why use Dispensable Gasketing and Sealing Materials?

- Reduction of Direct Labor Costs
- Reduction of Indirect Costs/Inventory Management
- Reduction of Scrap Materials
- Material Cost Reduction
- Ease of Accommodation of Engineering Changes

What you Need to Know About your Assemblies

- Design Gap: How big is the area between the parts

- Slopes and Angles on the Part: Steep angles require thixotropic materials

- Channel Design: If no channel is utilized then typically 2:1 ratio width to height is required

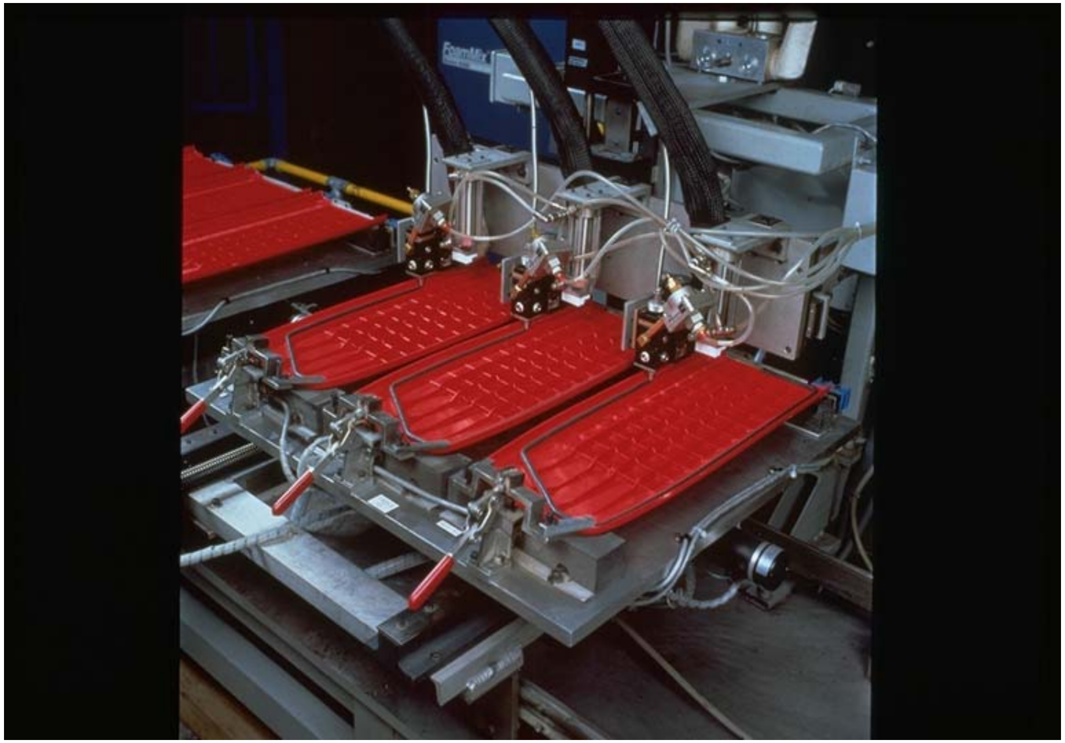
- Material Expectations: Height, forces used to compress, compression against angles, etc.

Questions that Define what Type of Material You will Need

- What is the Service Temperature?
- Does it need to be Serviceable?
- What is the Design Gap or Distance to the Mating Surface?
- What are the Required Dimensions & Compressions Requirements?
- Process Requirements: How many per hour?
- Costs per Piece Comparisons:High volume / volume considerations?
- What will be the Environmental Exposure (UV,Salt. Humidity, etc)?
- What other Chemical Resistance Required (Gasoline,Oil, Brake Fluids, etc)?

What Type of Automation?

- Three Axis Automation
- Six Axis Automation
- Inline Applications
- Spin Devices
- Shuttle Tables
- Rotary Tables
- Material Handling
- Heat & Humidity Chambers
- Cooling Fans
- Humidifiers
- UV Lights



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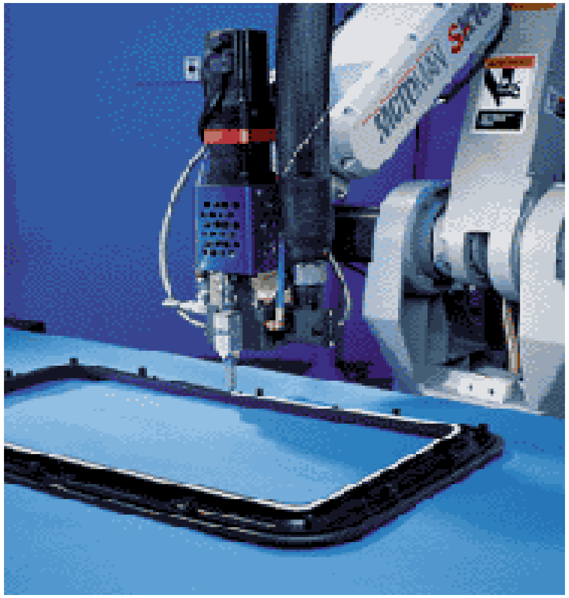
Dispensable Materials for Gasketing & Sealing

- One Component Polyurethanes
- Two Component Polyurethanes
- Foaming Two-Component Polyurethanes
- Hot Melt Sealers
- Butyl & Mastic Sealants
- Silyl Modified Polymers
- Silicones
- UV Curable



One-component Polyurethanes (Foamed & Unfoamed)

Polyurethane, PU
Polymer made by the reaction of polyols with a multi-functional isocyanate. Its molecular structure may cross-link and become a thermosetting plastic, or stay linear and remain thermoplastic.

- Advantages
  - Very thick, allows for dips and will not flow
  - Serviceable seals
  - Less than 1% isocyanate content, no waste generation
  - Can be foamed for softness
- Disadvantages
  - Moisture cure can require heat & humidity chamber
  - Careful immediate handling after dispense
  - Cure time
  - Six-month shelf life of material
  - Limitations to height and landing area ratio

Two-component Liquid Polyurethanes (Foaming & Non-foaming)

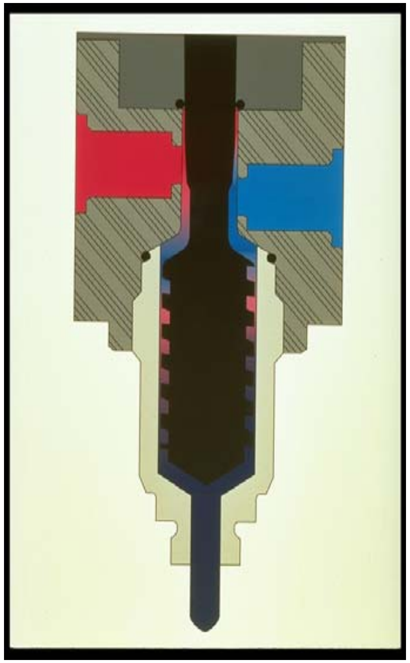
Polyurethane, PU
Polymer made by the reaction of polyols with a multi-functional isocyanate. Its molecular structure may cross-link and become a thermosetting plastic, or stay linear and remain thermoplastic.

Advantages

- Serviceable seals
- Relatively quick cure times
- Excellent channel fill material
- Wide variety of hardness and softness available

Disadvantages

- Measurable isocyanate content typically 3-6%, special handling & waste considerations
- Must gel before handling
- Material ratio mix & nucleation is crucial to material performance
- Six-month shelf life on materials
- Typically requires channel or captured landing area



Two-component Dispense Gun

Hot Melt Thermoplastic Sealers

- **Hot Melt: 100% solids adhesive requiring heat to raise the temperature of the adhesive to a workable viscosity.**
- **Thermoplastic: A material which repeatedly softens as temperatures rise and hardens as temperatures fall.**

Advantages

- Fast setting, heat dispersement only
- One time seals
- Several variations of hardness and softness are achievable
- Highly compressible/ force to compress
- Custom fit seal after set
- No special handling
- Unlimited shelf life
- Repositionability
- Can be foamed

Disadvantages

- No compression recovery
- Lower high temperature resistance as compared to cross-linked materials
- Limitations to achievable heights/ and landing required to hold the bead

Butyls and Mastic Sealers

Butyl rubber:

Butyl rubbers are copolymers of isobutene and small amounts of isoprene.
These rubbers are frequently mixed with natural and styrene-butadiene rubbers for obtain special properties, like resistance to aging, initial tack at low temperatures, and good peel-off.

- **Advantages**
  - Excellent one time adhesive seal
  - Simple dispense equipment
  - Usually have an adhesive quality

- **Disadvantages**
  - Are messy to work with
  - Some butyls contain solvent carriers
  - No compression recovery

Silicones

Silicon is the second most abundant element on earth. The variations of the material for gasketing and sealants is almost endless. It is available in almost all the forms listed in this paper. Each variation has its own advantages and disadvantages. When used primarily as a sealant, silicone is known for its ability to withstand large variations in temperature (-100°F to +600°F)

RTV (Room Temperature Vulcanizing): The tendency of an RTV adhesive to vulcanize (i.e. cure) at room temperature. Changes from a liquid/paste state to a solid, flexible rubber.

Advantages

- High heat resistance
- Many suppliers / many variations available

Disadvantages

- Many formulas cannot be used in the same locations as paint systems.

Ultraviolet Curing Systems

Photo-initiator agent: **which when exposed to a broad range of UV wavelengths of energy forms a reactive species which starts the chain reaction to cause polymer formation. Most commercial photo-initiators for free radical curing reactions contain modified benzoil groups, which are mainly responsible for the absorption of energy from light.**

- **Advantages**
  - Rapid curing (limited thicknesses)
  - For flat surfaces or wide shallow grooves
  - Many formulations available
  - Simple equipment for dispense
  - Good compression set resistance
  - Ability to hold various bead height for gap filling

- **Disadvantages**
  - Can be considered expensive due to high raw material costs

Silyl Modified Polymers (SMP)

Silyl Modified Polymers (SMP): are the main components of a new generation of solvent free and isocyanate free sealant and adhesive products

Advantages

- Hybrid between polyurethane and silicone yet contains neither
- High temp seals (<250F)
- Acts like rubber with adhesive qualities
- Moisture curing
- Simple dispense equipment
- Available in cartridges
- Primerless to glass
- Paint able

Disadvantages

- Can be slow curing
- Can be messy before cure
- Not very compressible after cure
- Cure can be accelerated by adding second component moisture catalyst

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What Type of Dispense Equipment Do I Need?

- How is the material supplied?
  - Drums, pails, tubes etc.
- Does the material need to be heated or conditioned?
  - Temp conditioning, high heat, no heat
- Does the material need a specific type of pump?
  - Gear pumps, piston pumps, gravity feed
- Are there any special handling requirements?
  - Ventilation, overtemp protection, airtight
- Does the material need to be mixed or conditioned?
  - Ratio’s, catalysts, nitrogen

Putting it all Together

- Put together a team of people. The team should consisting of an automation supplier, a dispense equipment supplier and a material supplier. Remember that each one has their own technology but they all must work together for your success.

- Be aware that many of these suppliers have experience and knowledge that will benefit your efforts such as: specialty software, special ways of fixturing or methods for curing, that is used in conjunction with dispensed gasket and sealant materials.

- Gasketing and sealing technology is changing and expanding everyday. This paper only touches on the very basics of what is available in the market today. Use this information as starting point and learn from the myriad of suppliers the possibilities that exist for your applications.

Glossary

- **Crosslinking:** Formation of chemical bonds between polymer chains leading to the formation of a three dimensional network. Final materials are called thermosets.
- **Cure:** (also see set / setting) to change the physical properties of a material through chemical reaction. Often accomplished through the reaction of heat and catalysts, alone or in combination, with or without pressure, often referred to as hardening or setting
- **Elastomer**: A synthetic rubber, plastic or other polymer which can be stretched to at least twice its original length then return to its original shape with force. The ability to return to its original shape is called *memory*.
- **Compression Recovery:** The measure of a materials ability to come back to it's original shape after being compressed or indented
- **Durometer Hardness:** A measure of the hardness of a material as measured by a durometer. The resultant numerical rating of hardness in Shore A softer material (30 or 40) to higher numbered, harder material (80 to 90).
- **Elastomer:** A synthetic rubber, plastic or other polymer which can be stretched to at least twice its original length then return to its original shape with force. The ability to return to its original shape is called *memory*.
- **Foaming:** The process of mechanically putting nitrogen gas into the molten hot melt material in order to effect the final characteristics of the material.
- **Foamability**: ability of a material to accept an inert gas and hold it in solution

Glossary

- **Meter Mix and Dispense Machine (MMD):** A machine designed to bring precisely measured volumes of material together from separate sources for mixing and dispensing.
- **Thermoset:** A material which hardens when first exposed to high temperatures and pressure but cannot be melted again without destroying its attributes
- **Thermoplastic:** A material which repeatedly softens as temperatures rise and hardens as temperatures fall.
- **Meter Mix and Dispense Machine:** A machine designed to bring precisely measured volumes of material together from separate sources for mixing and dispensing.
- **Sealant:** A material which adheres to two adjoining parts of an assembly and prevents the passage of gases, dust, liquids, etc. into or out of the assembly at that point.
- **Serviceable:** The ability of a material to maintain it's sealing capabilities after being disassembled and put back together
- **Viscosity:** The measure of a materials resistance to flow under specified conditions

For more information...

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The author has over 15 years experience working with automated gasketing systems. In that time he has placed hundreds of systems utilizing many of the materials referenced in this paper.

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