NASA TECHNOLOGY TRANSFER

Commercial Applications of Aerospace Technology

Technology Opportunity

Thermal Gasket

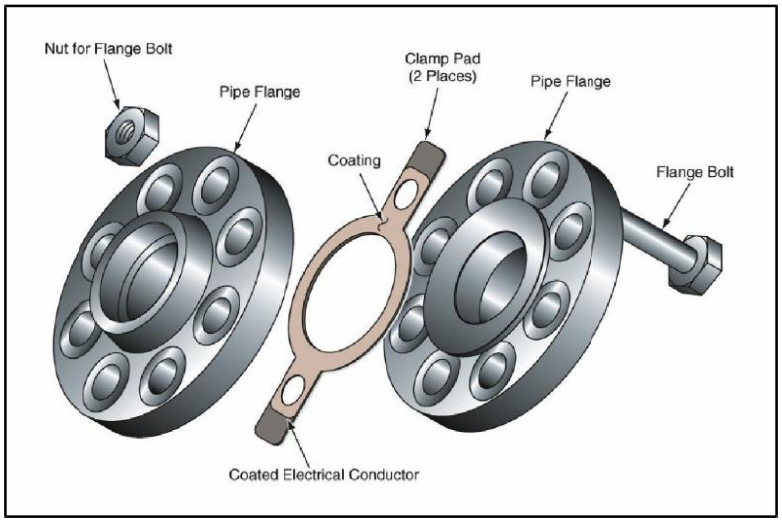
Combines the Benefits of Both Static Seals and Liquid Sealants with Added Serviceability

The National Aeronautics and Space Administration (NASA) seeks qualified companies for further development and commercialization of a new gasket technology. This gasket, which was developed at the Marshall Space Flight Center, consists of an electrically conductive substrate coated on both sides with a thermoplastic or braze alloy. When the substrate is heated by passing an electrical current through it, the coating melts. Preliminary tests have shown that this low-cost technology can fill imperfections and adhere like a liquid sealant or braze, creating a zero-leakage joint that can easily be disassembled for service.

Potential Commercial Uses

The thermal gasket could be used in a wide variety of static sealing applications for flanged piping and housing joints, particularly where there may be imperfections in the joint and where future disassembly is a priority. Examples include:

- Chemical/industrial piping joints
- Marine engine housing joints
- HVAC steam and chilled water piping joints
- Automotive engine cooling system housing joints.



The Technology

Conventional gasketed joints can leak for several reasons, including surface irregularities, joint pressure extrusion, and stress relaxation. Liquid sealants were developed to reduce leaks by filling surface imperfections, adhering to joint surfaces, and minimizing gasket thickness. However, in liquid sealant applications, process control is difficult, curing is time consuming, fumes introduce an environmental hazard, and servicing can be difficult. Liquid sealants used in a highly finished joint can fail, resulting from sealant breakdown or extrusion. Brazed joints present similar challenges as well as adding a safety risk from the heat source.

To address the limitations of these conventional joining and sealing technologies, NASA developed the thermal gasket. The thermal gasket consists of an electrically conductive substrate that is coated on both sides with a thermoplastic or braze alloy. Alternatively, the conductive substrate could be an independent layer with the thermoplastic or brazed alloy layers mated to the substrate.

To install, the thermal gasket assembly is first positioned in the joint under a light preload. An electrical current is passed through the substrate to heat it and melt the thermoplastic or braze alloy. At this point, the joint can be fully preloaded. Some excess thermoplastic or braze alloy may be squeezed out of the joint, but this can be minimized by controlling the amount specified on the substrate. The gasket is fully cured within a few minutes after the current is disconnected from the substrate.

Using an alternative installation method, one could fully preload the joint before melting the gasket. This method requires more up-front design effort to control the resulting stress relaxation of the thermoplastic or braze alloy. To disassemble, one would remove the

preload, connect the current source to the substrate to melt the thermoplastic or braze alloy, and separate the joint.

Selecting this gasket technology is similar to other composite gasket selection procedures. The maximum operating temperature for a braze-alloy-based thermal gasket would be about 900°F, whereas a thermoplastic-based thermal gasket could operate up to about 400°F. Because of conductive heat losses and the amount of electrical current required to overcome them, a braze-alloy-based thermal gasket may be limited to subassemblies with a small heat sink.

Benefits

- *Serviceable*—Gasket can be remelted in-situ for easy joint disassembly.
- *Environmentally Friendly*—Does not produce VOCs during curing.
- *Reduces Surface Finish Requirements*—Thermal gasket fills imperfections like liquid sealants.
- *Easily Manufactured*—Technique is compatible with existing gasket cutting systems for simple or complex geometries.
- *Stable*—Joints sealed with thermal gaskets can be thinner than those sealed with a standard gasket, reducing relaxation problems.
- *Reduces Process Variance*—Gasket eliminates sealant distribution and control problems during joint assembly.
- *Easy to Use*—Gasket can be instantly positioned by machine or hand.
- *Fast*—Thermal gaskets can melt and cure in a few minutes.
- *Economical*—Technique results in savings in assembly, process control, effectiveness, reliability, equipment down time, and servicing.
- *Low Ignition Risk* —Technique utilizes electrical resistance heating process.

Proof of Concept

Several proof-of-concept gaskets have been fabricated and one test has been performed. For the test, a 0.007-inch-thick mild steel substrate was coated with a standard hot melt adhesive using a commercial applicator. This inside bolt circle thermal gasket assembly was then positioned between two 2-inch nominal 150-lb (carbon steel) flat-faced steel pipe flanges under a light preload. A 220-volt commercial arc welder was then connected to opposite ends of the substrate, which drew approximately 200 amps of current for about two minutes. At that time, the thermoplastic was melted and the four flange bolts were torqued to approximately 65 ft-lbs. The current source was disconnected and the joint was allowed to completely cool. The completed joint was then pressurized to 150 psi with helium and continuously monitored for leaks for approximately 30 minutes. The joint was then depressurized, subjected to severe random vibration for 180 sec/axis, and repressurized for further leak testing. No leaks were found.

Options for Commercialization

This technology is part of NASA's Technology Transfer program. The program seeks to stimulate the use of NASA-developed technology by the commercial sec- tor. NASA is flexible in its agreements, and opportuni- ties exist through cooperative development and/or patent licensing (nonexclusive, exclusive field-of-use, or exclusive). Patents 6,578,851 and 6.394,501.

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