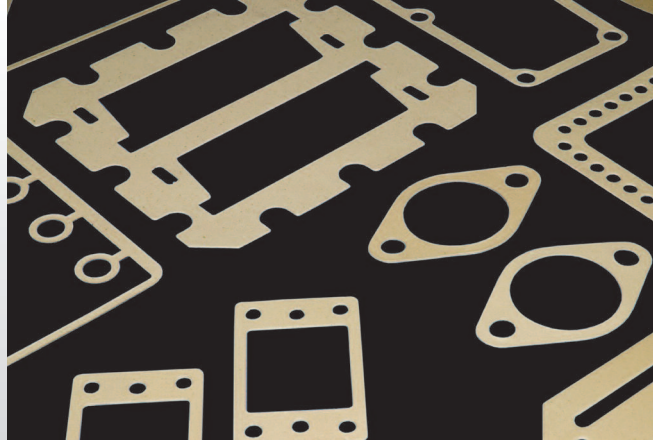


PRODUCT DATASHEET

THERMICULITE® 866 LS



Thermiculite® 866 cut gasket samples

A compression sealing material designed for solid oxide fuel cell (SOFC) applications where the service temperature is 700°C or more and the compressive loading only generates a low compressive stress, even as low as 0.1 MPa.

Thermiculite®
innovative. versatile. complete.

This Data Sheet refers to the material as supplied. The information contained herein is given in good faith, but no liability will be accepted by the Company in relation to same.

We reserve the right to change the details given on this Data Sheet as additional information is acquired. Customers requiring the latest version of this Data Sheet should contact our Applications Engineering Department.

The information given and, in particular, any parameters, should be used for guidance purposes only. The Company does not give any warranty that the product will be suitable for the use intended by the customer.

This material consists of Thermiculite® 866 with a thin coating on each sheet surface of a beige coloured finish which contains a glass powder. The glass used was formulated for SOFC sealing applications, is very finely ground, and melts at below 700°C. Thermiculite® 866LS was designed to allow excellent sealing in those applications where the loading on the gasket is not high enough to allow a seal to be created with Thermiculite® 866.

The beige coloured surface finish contains, apart from the glass powder, an acrylic binder, organic pigments and processing aids and a minor amount of borax. In service this binder system burns off before the temperature reaches the melting point of the glass powder. Once the glass powder melts it creates a conformable and viscous layer between the Thermiculite® 866 core and the surfaces to be sealed. This layer fills the surface imperfections in the surfaces to be sealed and allows the creation of a seal at a much lower stress than is possible with Thermiculite® 866 alone.

During the use of Thermiculite® 866LS gaskets no initial glass sintering cycle to above the operating temperature of the SOFC stack is required. Provided that the stack operating temperature is at least 700°C the glass coating will form the required seal.

The details of the Thermiculite® 866 core are given in the Thermiculite® 866 Data Sheet and will not be repeated here.

Approvals / Compliance:

BAM for Oxygen approved.

Availability:

Thermiculite® 866LS is available as either cut gaskets or in sheet form.

Maximum sheet size:

450mm x 350mm.

The stocked thicknesses of Thermiculite® 866LS are produced by applying the LS coating to Thermiculite® 866 of the standard 0.3, 0.5, 0.7 and 1.0 mm thicknesses. Other thickness are available on request.

The coating increases the sheet thickness by about 0.15 mm but in service, when the organic components of the coating have burnt off, the glass will have a thickness of about 18µm on each side of the gasket core.

If required, cut gaskets of Thermiculite® 866LS can be supplied rather than sheet. This service is offered at no extra charge and, if required, a non-disclosure agreement will be signed to protect the confidentiality of the drawings required in order to offer this gasket cutting service.

Continued on the following page

PRODUCT DATASHEET

Typical Physical Properties:

Typical properties of Thermiculite® 866 are detailed in the Thermiculite® 866 data sheet.

For the Thermiculite® 866LS data given below the test samples were heated at 60K / hour and there were no dwell periods during the heat up to the test temperature. The test temperatures were 700°C unless otherwise stated.

Figure 1, right, gives a comparison at 700°C of the sealing of Thermiculite® 866 and Thermiculite® 866LS as a function of gas pressure and gasket stress.

Figure 2 shows the robustness of the sealing of Thermiculite® 866LS against thermal cycling. In this figure the sealing after five thermal cycles, shown as the dashed lines, remains as expected from the data obtained before the thermal cycles.

Figures 3 and 4 illustrate the sealing performance of Thermiculite® 866LS at 700°C and 850°C respectively.

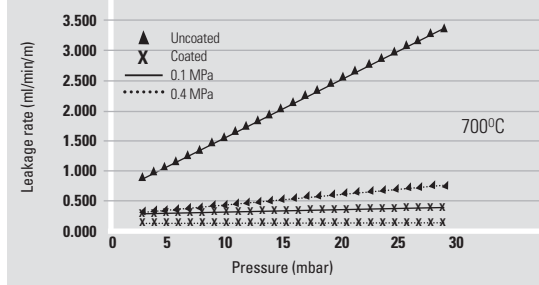
Health & Safety

This product is believed to present no health and safety hazard during gasket cutting, in use or on removal after service. In normal use it is unlikely that the product will give rise to significant levels of exposure to the constituent materials.

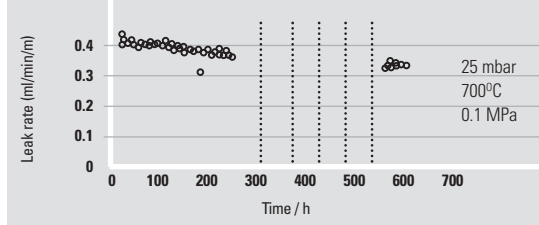
Flexitallic Thermiculite® 866LS comprises chemically exfoliated vermiculite and steatite with a coating as detailed in their third paragraph of this document.

Under harsh mechanical treatment (e.g. high speed stamping operations or abrasion) the constituents may give rise to irritant dust which, in extreme cases of exposure, could lead to more serious respiratory problems. Occupational exposure to such dusts should therefore be minimised and kept below relevant national exposure limits. Good standards of hygiene should be applied during gasket cutting operations and off-cuts should be disposed of by transfer to a site appropriately licensed to accept industrial materials of this nature.

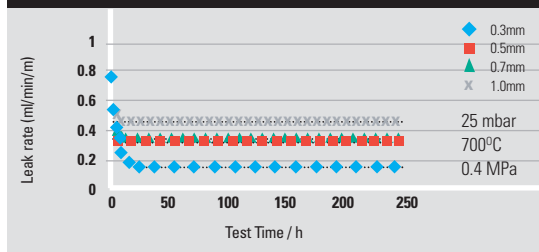
1 COMPARISON OF SEALING OF THERMICULITE® 866 & THERMICULITE® 866 LS AS A FUNCTION OF GAS PRESSURE AND GASKET STRESS



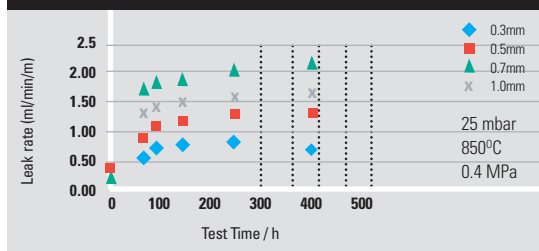
2 THE ROBUSTNESS AGAINST THERMAL CYCLING AND SEALING PERFORMANCE OF THERMICULITE® 866 LS



3 SEALING RESULTS AS A FUNCTION OF GASKET THICKNESS AT 700°C



4 SEALING RESULTS AS A FUNCTION OF GASKET THICKNESS AT 850°C



Best Sealing Practice:

To obtain the best performance from a sealing material the following considerations apply just as much to an SOFC as to an industrial pipeline gasket:

- Minimize the gasket area as far as possible taking into consideration gasket handling
- Maximize the compressive load available
- Use studs of the appropriate metal and stress to a high percentage of yield
- Minimize load loss by making the studs as compliant as possible by using the minimum stud diameter suitable and by using extension collars or constant load washers such as Belleville washers
- Tighten the studs in a cross pattern manner
- Tighten the studs using either controlled torque or hydraulic tensioners
- With torque tensioning use a reliable lubricant having a known friction factor
- Unless the gasket is compensating for connection defects, always use the minimum practical thickness
- The surfaces to be sealed should preferably have ground rather than a turned finish but they should certainly be free from transverse machining marks or scratches. An appropriate surface finish is N6, Ra 0.8 μm, CLA 32 μ" / Rz 3.20 μm, 126 μ" or better.

When correctly selected and used, an appropriate gasket is able to provide a seal whilst allowing the cost of the SOFC stack to be reduced via the use of less bolt load, less rigid stack components and reduced tolerances for the components to be sealed.

Sample material for evaluation

Sample material or sample cut gaskets for evaluation can be obtained without charge from:

For Europe and Asia

John Hoyes
www.flexitallicsofc.com
Email: jhoyes@flexitallic.eu
Phone: + 44 7767 341985

For the Americas and China

Stephen Bond
www.flexitallic.com
Email: sbond@flexitallic.com
Phone: +1 281 604 2477