

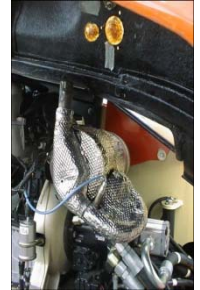
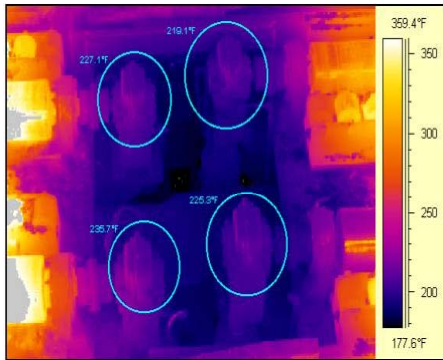




ThermoDyne Advanced Microporous Insulation Materials and Systems for High Temperature Applications



ThermoDyne Introduction





ThermoDyne Introduction



Plant 3. 143,000 sqft with 10 acres



Plant 2. 30,000 sqft with 4 acres

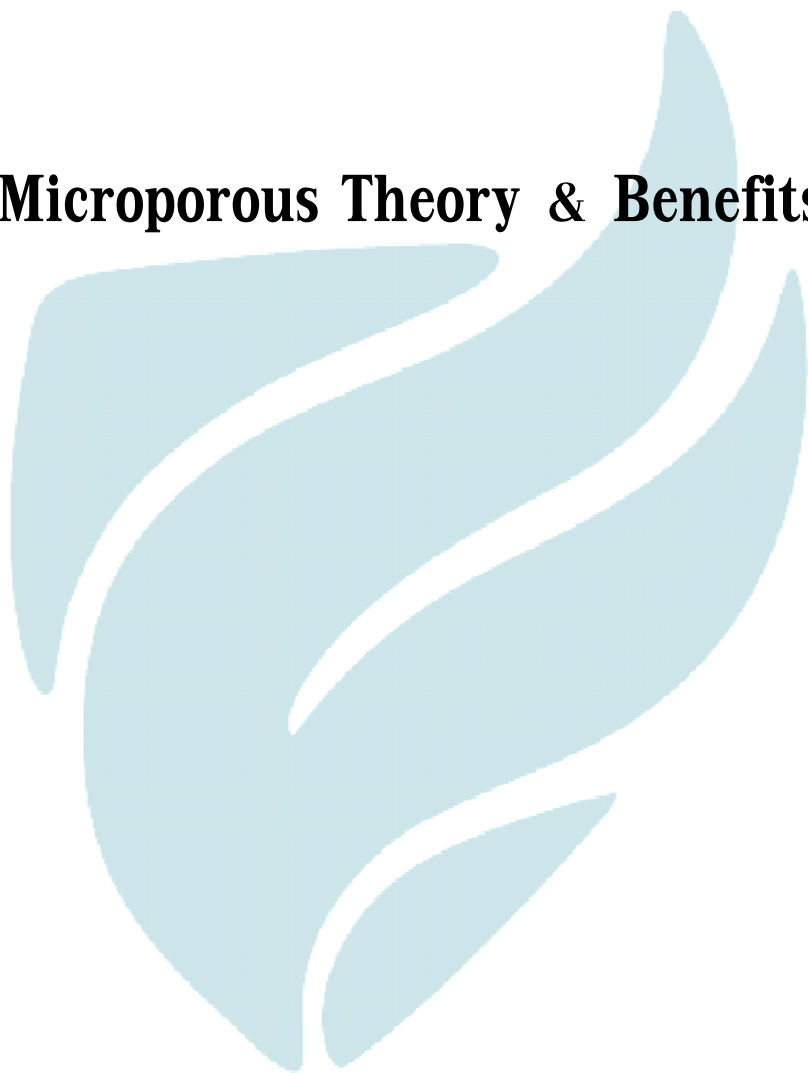
ThermoDyne Introduction



ThermoDyne Introduction

- ❑ 178,000 SF total facilities
- ❑ Materials are currently used and/or specified by many such as Boeing (747,767,757,727), ITT, Bechtel, Grumman, and GM, General Dynamics, BAE, L3, Navy, Air force, and many others.
- ❑ Currently sales and distribution in 8 overseas countries

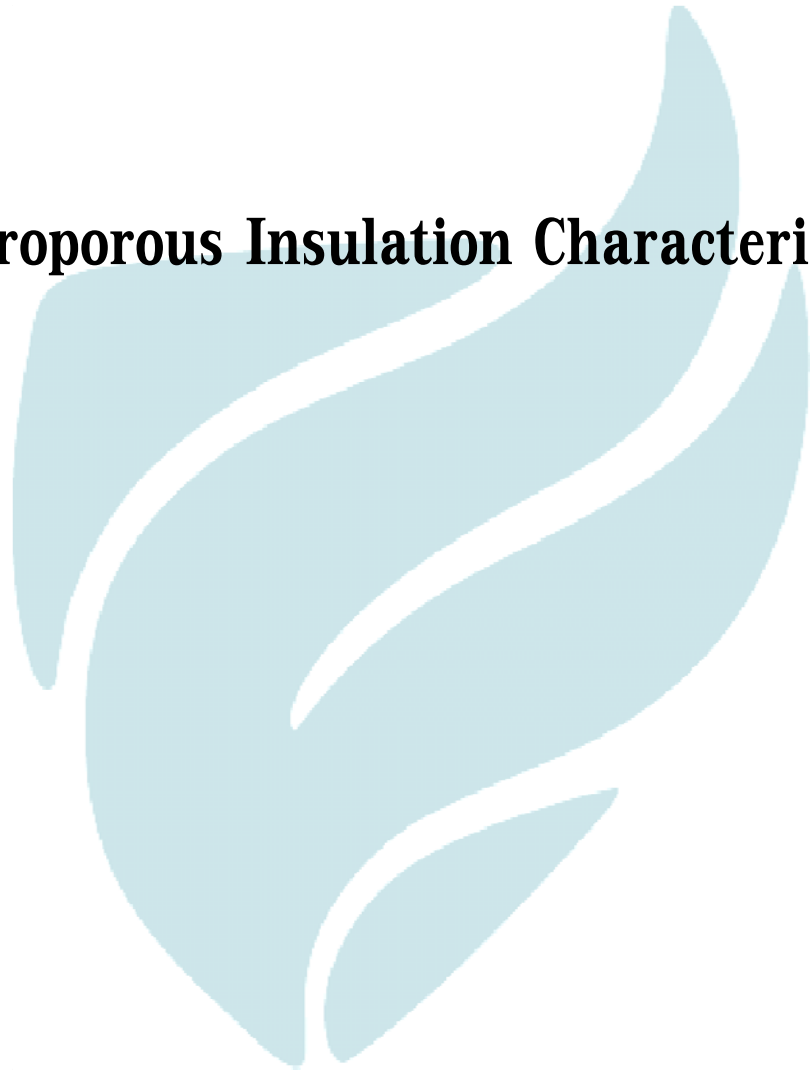
Microporous Theory & Benefits



Microporous Theory & Benefits

- ☐ History
 - ☐ Physics
 - Convection
 - Conduction
 - Radiation
 - ☐ Space & Weight Savings
 - ☐ Improved Operational Efficiency
 - ☐ Energy Conservation
- 

Microporous Insulation Characteristics



ThermoDyne Microporous Systems

□ Physical Characteristics

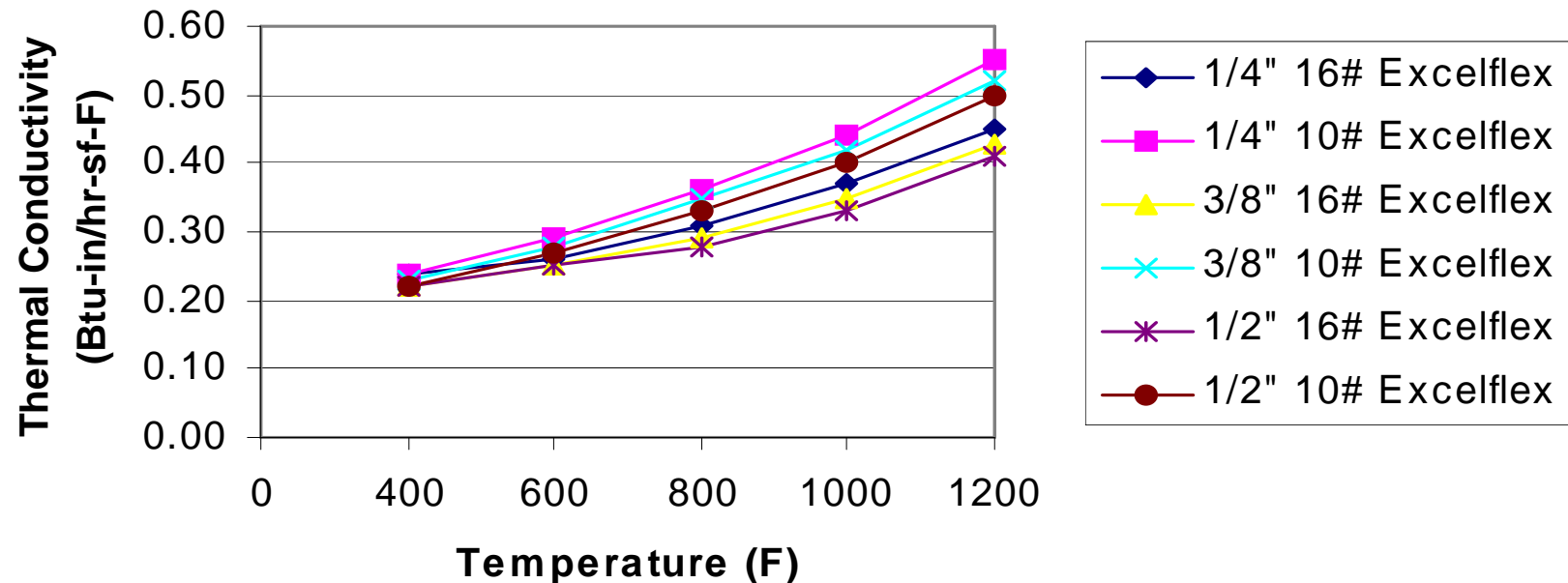
- Essentially a fine silica based, powdery substance comprised of a blend of powders and fibers.
- Can be provided with or without additional composite materials such as fabric or metal shells, and can easily be custom fabricated by ThermoDyne to fit highly specialized shapes, sizes and application requirements.

ThermoDyne Microporous Systems

□ Density and Thickness

- The performance changes a bit with density.

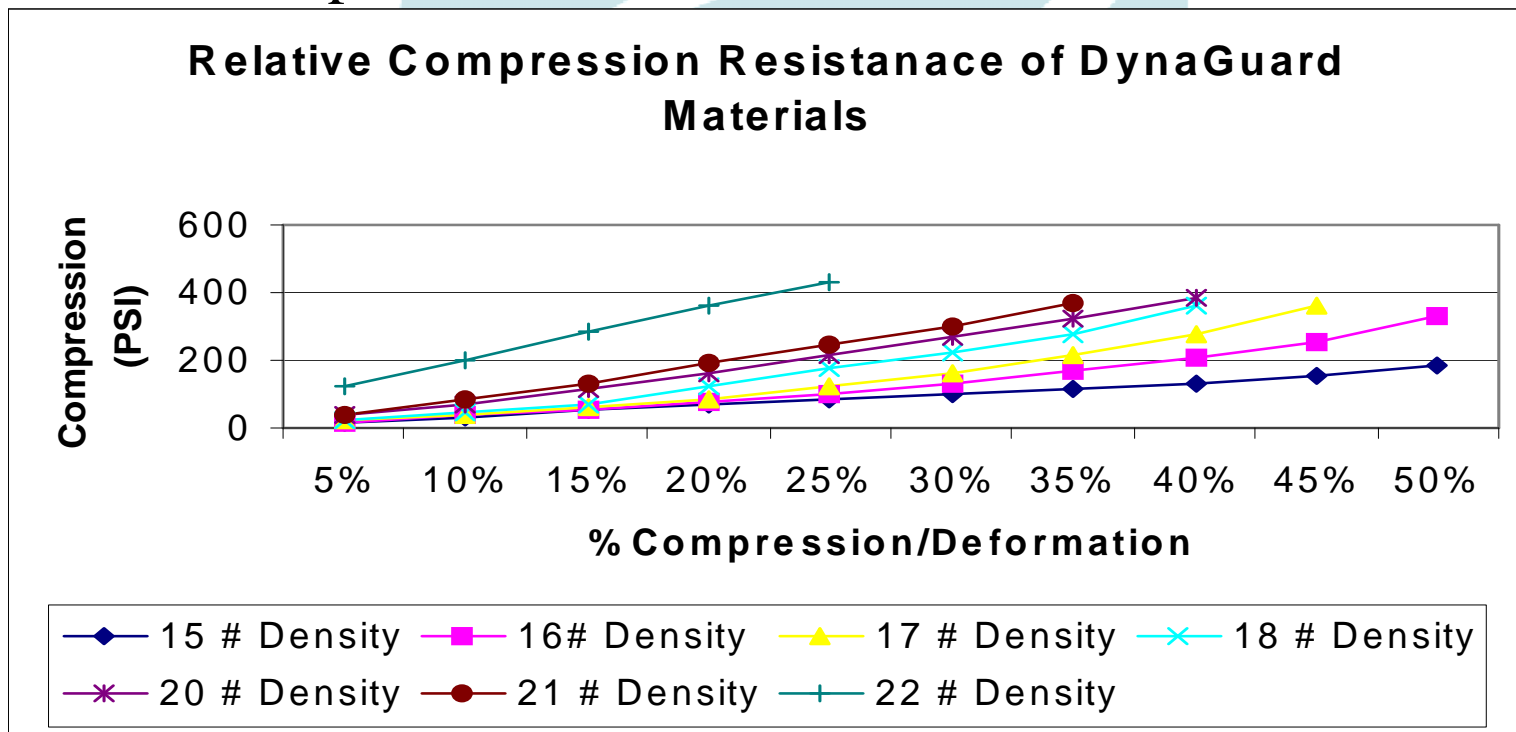
Performance Comparison: Density vs. Thickness



ThermoDyne Microporous Systems

□ Compression Resistance

- ThermoDyne microporous materials are highly resistant to compression forces.



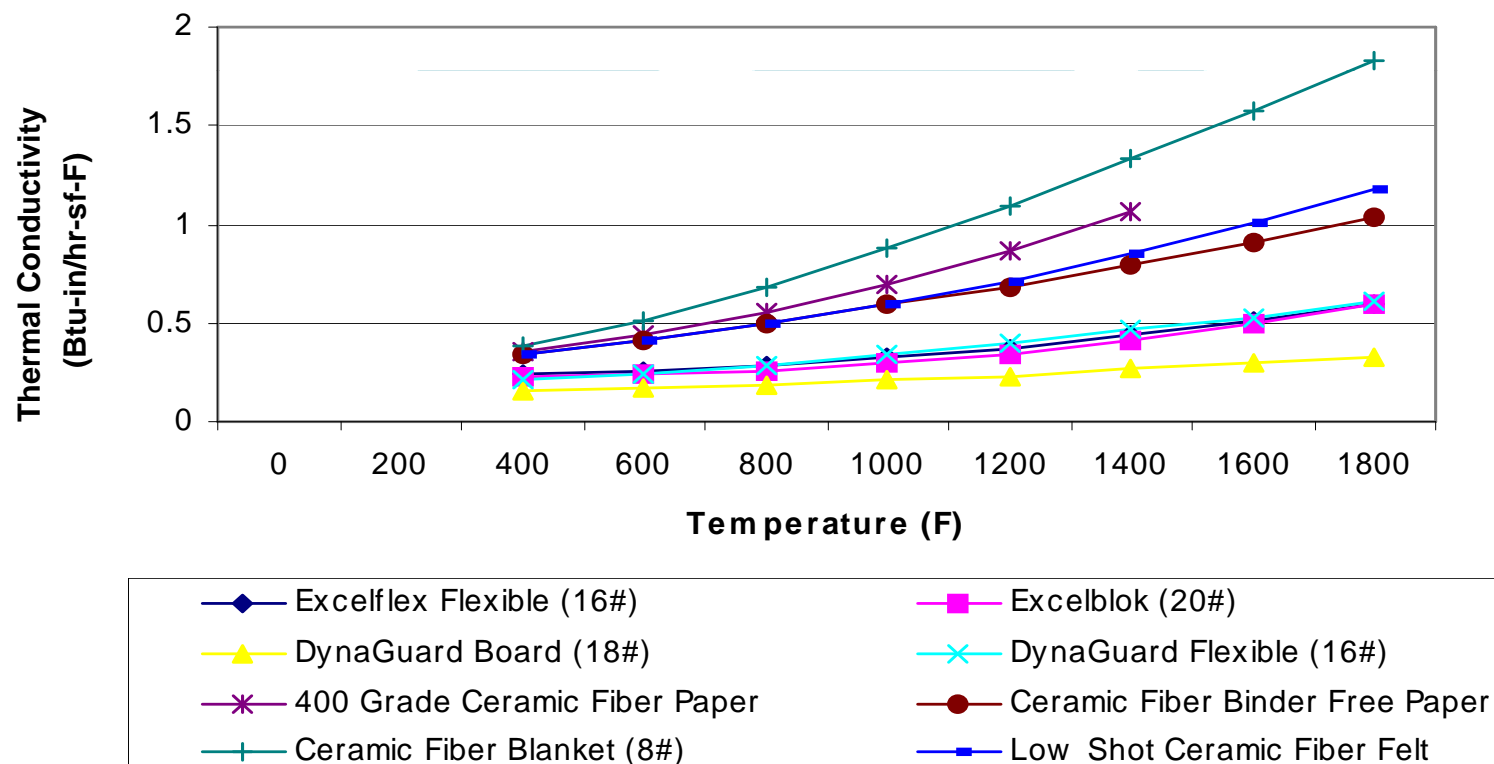
ThermoDyne Microporous Systems

❑ Thermal Conductivity

- ThermoDyne microporous materials are extremely thermally efficient, and possess thermal conductivity values even lower than still air.
- This makes them among the most efficient insulators currently available on the market today.
- ThermoDyne microporous insulation materials consistently outperform other conventional insulation systems.

ThermoDyne Microporous Systems

Overall Average Thermal Conductivity Performance of Eight Materials



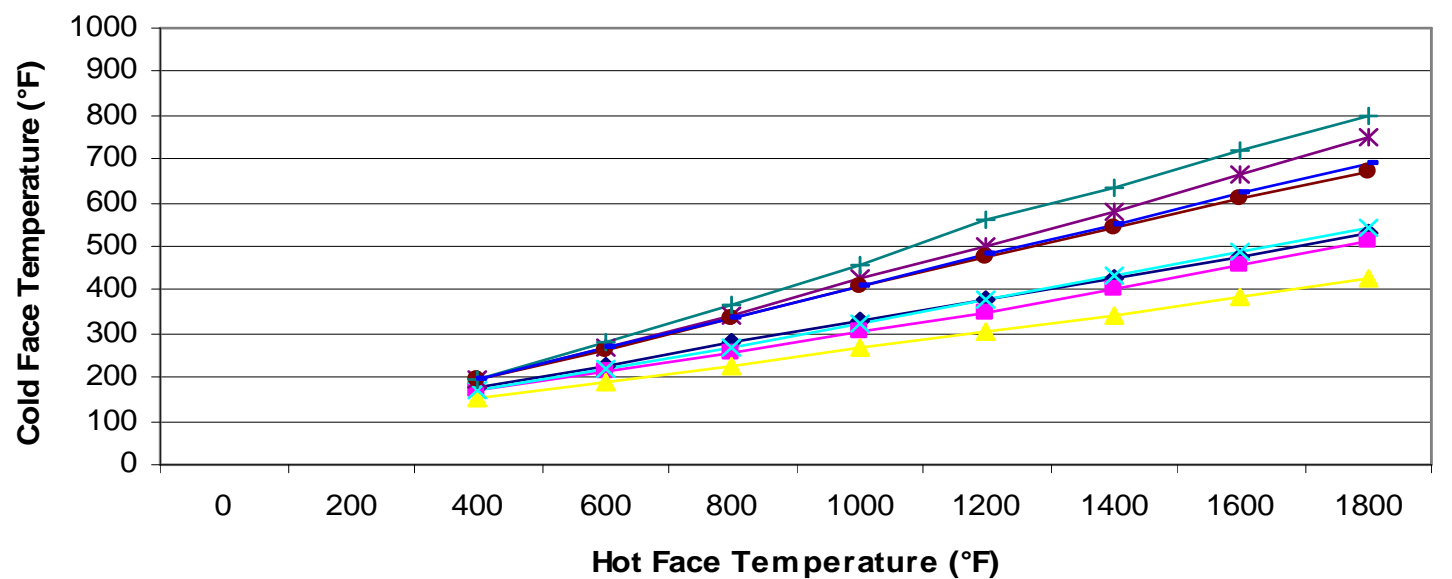
ThermoDyne Microporous Systems

❑ Yielded Cold Face Values

- ThermoDyne microporous insulation systems are capable of providing lower yielded cold faces within given space or weight requirements than virtually any other material currently available.
- At max temperatures (1800°F), a 1/4" thickness of ThermoDyne microporous insulation yields a cold face nearly 200° lower than the nearest competitive material (illustrated on the following graph).

ThermoDyne Microporous Systems

Cold Face Analysis of Eight 1/4" Materials



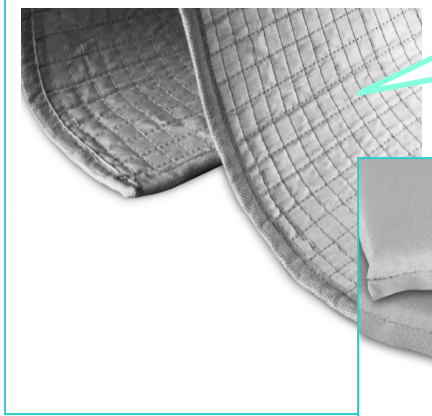
- ◆ Excelflex Flexible (16#) 1/4"
- ▲ DynaGuard Board (18#) 1/4"
- * 400 Grade Ceramic Fiber Paper 1/4"
- + Ceramic Fiber Blanket (8#) 1/4"
- Excelblok (20#) 1/4"
- × DynaGuard Flexible (16#) 1/4"
- Ceramic Fiber Binder Free Paper 1/4"
- Low Shot Ceramic Fiber Felt 1/4"

ThermoDyne Microporous Systems

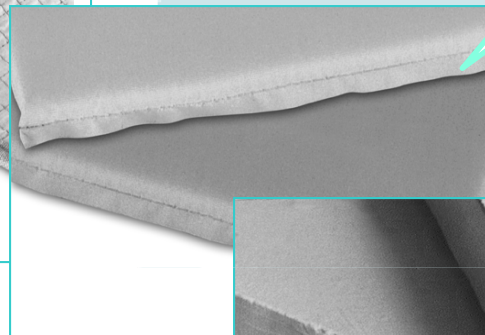
□ Additional Characteristics

- Linear Shrinkage
- Hydrophobic vs. Hydrophilic Nature of the Material
- Vibration Resistance

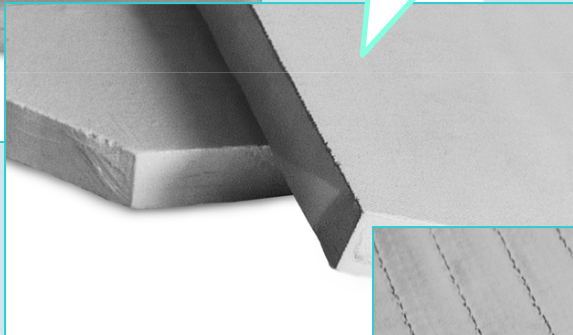
Microporous Insulation Product Forms



Flexible



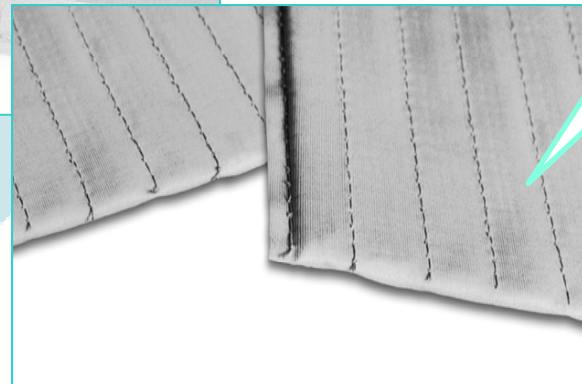
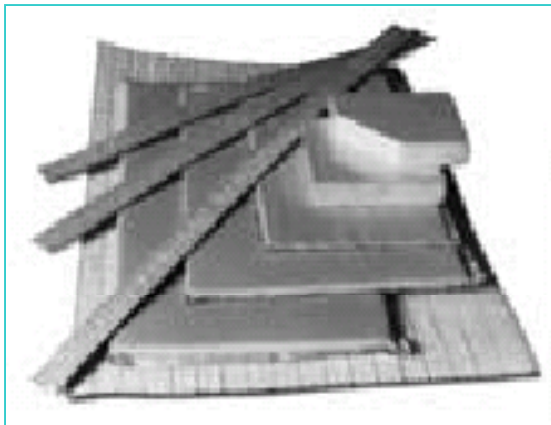
Panel



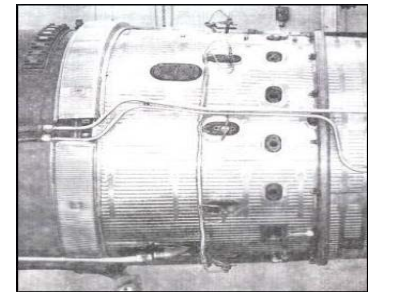
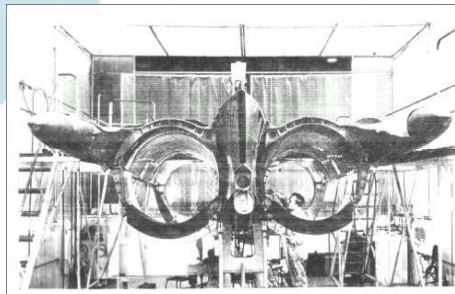
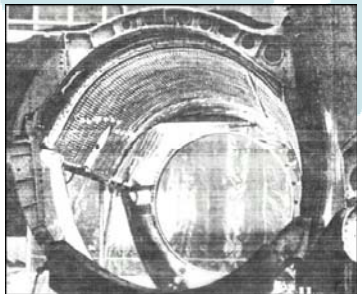
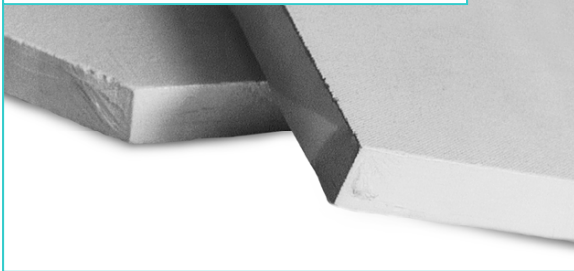
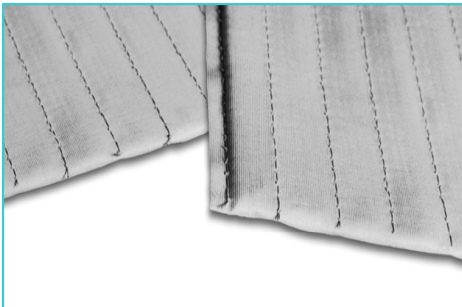
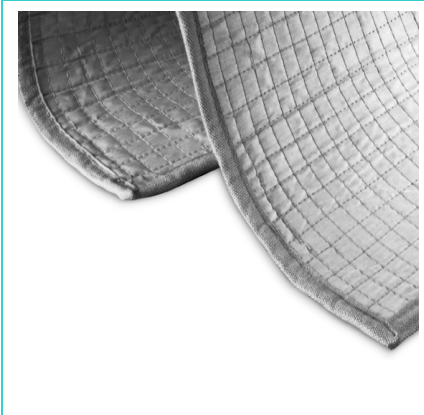
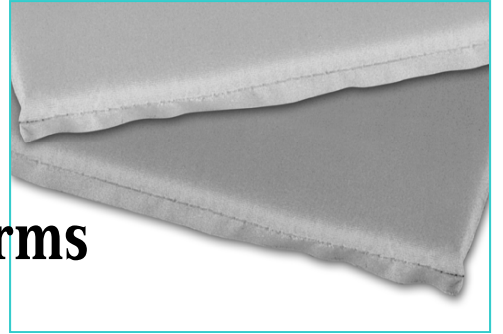
Board



Ladle
liner

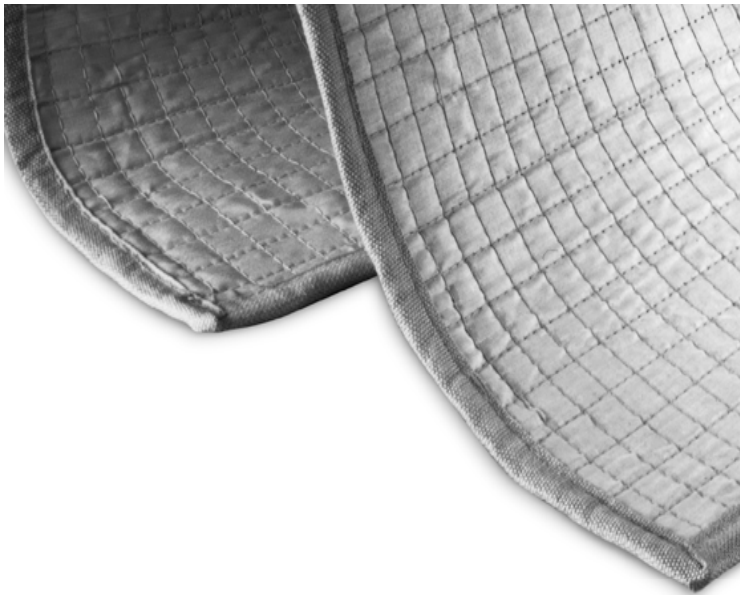


Microporous Insulation Product Forms



Microporous Insulation Product Forms

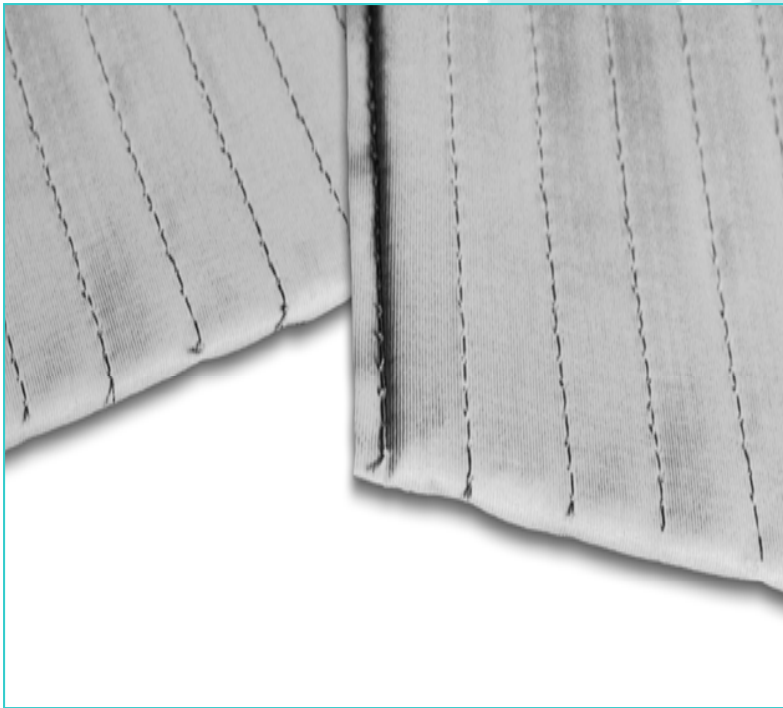
Flexible Product Forms: ThermoDyne flexible products are comprised of a light-weight microporous core material encapsulated between two layers of high temperature cloth and multi-stitched with high temperature thread.



- ThermoDyne supplies both Excelflex® for aerospace/space applications, and DynaGuard™ Flexible materials for industrial/commercial applications.
- Flexible forms are ideal for applications where the insulation material must conform around curves, contours, or irregular shapes.
- Flexible forms can be manufactured with a variety of cloth facings and thread, depending upon the need of the application.
- Flexible forms are highly resistant to vibration, and can easily be encapsulated by metal or other materials to achieve moisture, abrasion, or added vibration resistance.

Microporous Insulation Product Forms

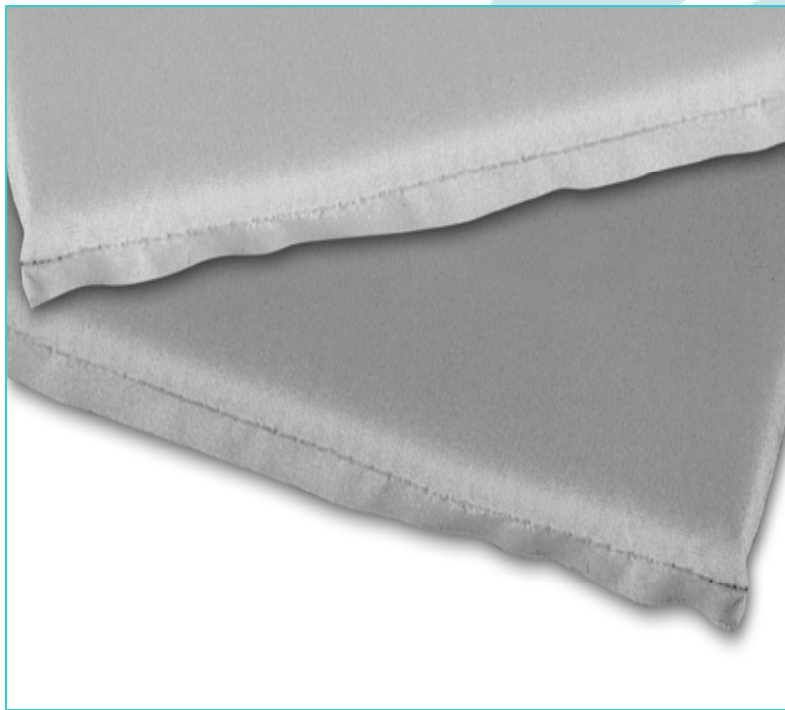
Ladle Liner Product Forms: ThermoDyne Ladle Liner products are comprised of a light-weight, hydrophobic Microporous core material encapsulated between two layers of high temperature cloth and multi-stitched with high temperature thread.



- Ladle Liner product forms can be easily fit around curves, contours and irregular shapes.
- Ladle Liner product forms are highly resistant to vibration, and can easily be encapsulated by metal or other materials to achieve additional moisture, abrasion, or vibration resistance.
- Ladle Liner product forms are ideal for environments where the microporous core material may come in contact with substantial moisture (Note: the hydrophobic component of the material burns out of the mixture at between 600 - 900°F).

Microporous Insulation Product Forms

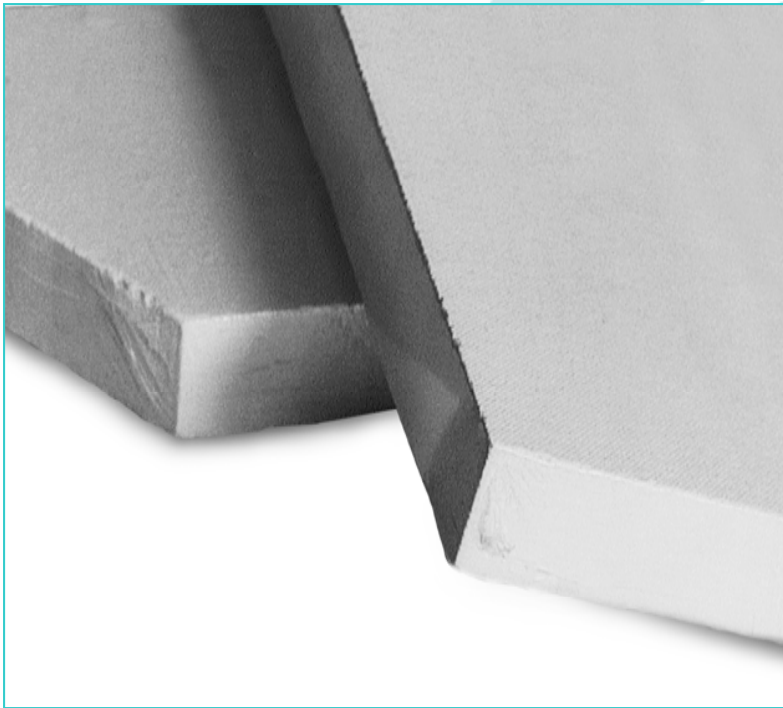
Panel Product Forms: ThermoDyne panel products are comprised of a higher density microporous core material encapsulated between two layers of high temperature cloth.



- Panel systems are ideal for applications where the insulation materials do not need to be butt-jointed or intricately fabricated or manufactured in the field.
- Panel systems can be manufactured with a variety of cloth facings, as well as in non-standard sizes and shapes, depending upon the need of the application.
- Panel systems are easy to handle, easy to install, and considerably more cost effective than most Board materials.

Microporous Insulation Product Forms

Board/Rigid Product Forms: ThermoDyne board products are comprised of a higher density microporous core, and are easily fabricated by conventional means.



- ThermoDyne supplies both Excelblok™ materials for aerospace/space applications, and DynaGuard® Board systems for industrial/commercial applications.
- Both Excelblok™ and DynaGuard® Board systems are ideal for applications where the insulation materials are required to be butt-jointed or intricately fabricated/manufactured in the field.

Microporous Insulation Product Forms

Cavity Fill Product Forms: ThermoDyne cavity fill products are comprised of a light-weight microporous material.



▪ DynaGuard Cavity Filler insulation systems represent one of ThermoDyne's microporous products for primary use in industrial and commercial applications. The DynaGuard cavity fill system is a pourable, granule based material comprised of microporous insulation for use where conventional products cannot be used. It is ideal for fill the cavities of complex shapes and structures. Cavity Filler provides excellent thermal protection with minimum space and weight requirements.

Microporous Insulation Product Forms

Tape Product Forms: ThermoDyne flexible tape products are comprised of a light-weight microporous core material encapsulated between high temperature cloth. Patent 8262826



ThermoDyne Tape systems represent one of thermodynes microporous products for primary use in industrial and commercial applications. Dynaguard Tape system is a flexible textile encased comparatively dense material with high compression resistance and exceptional strength and its superior thermal performance allows the maximum amount of thermal protection to be provided within minimum space and weight requirements.





Microporous Insulation Product Forms



DynaGuard™ 1600
Microporous Insulation

DynaGuard™ 1600 Insulation Systems DynaGuard™ 1600 Insulation Systems represent one of ThermoDyne's microporous products for use in industrial, commercial, and automotive applications. The DynaGuard™ 1600 is a flexible and malleable composite system, ensuring compressive strength and high compression resistance and exceptional strength and its superior thermal performance allows the maximum amount of thermal protection to be provided within minimum space and weight requirements.

DynaGuard™ 1600 systems are also specially formulated to minimize heat transfer via conduction, convection and radiation through the material by use of the following:

Ceramic Powders with Intrinsic Low Thermal Conductivity

The microporous core materials used in the manufacture of DynaGuard™ 1600 systems possess a thermal conductivity even lower than that of still air, and minimize the solid conduction of energy through the material.

Microporous Structure

The microporous structure of the DynaGuard™ 1600 system inherently minimizes the possibility for air current convection through the material as void spaces are too small for air currents to exist between the core material components.

Special Opacifiers

The introduction of special opacifiers into the DynaGuard™ 1600 formulation ensures that the transmission of infrared radiation through the material is kept to the lowest possible levels.

DynaGuard™ 1600 Materials of Construction

The DynaGuard™ 1600 microporous core material is a 1,600°F continuous use formulation, and is compressed into a uniform thickness and density to ensure the proper distribution of the core material. After compression, the material is quilted on 1" parallel centers (other stitch patterns available) with a poly thread in order to provide both flexibility and greater vibration resistance for the material.

DynaGuard™ 1600 can be hydrophobic or non hydrophobic depending on the need. The hydrophobic material minimizes its hydrophobicity up to 62°F.

In addition to the hydrophobic microporous core, DynaGuard™ 1600 systems are supplied encased in many different coverings. The standard configuration is an aluminum foil with fiberglass veil combination that gives the material conformability that holds its shape, and a practically dust free surface for ease of handling. Parts can be taped together easily if desired. The surface and the compression resistance of the material make for a perfect combination for all pipe and vessel covers, especially composite cure systems because of minimum dust on the surface which allows good tack and adhesion of the material.

DynaGuard™ 1600 systems are supplied standard at 12lb/ft³ density. Other densities available. The standard sheet size is 36"x72". Other sizes available. Thicknesses of 1/4" and 1/2", and 5mm and 10mm are standard. Other thicknesses available.

DynaGuard™ 1600 Insulation Systems Advantages

Lowest Thermal Conductivity
Because DynaGuard™ 1600 systems inherently possess a thermal conductivity lower than that of still air, even at elevated temperatures, they are ideal in environments where materials with low thermal conductivity, thermal diffusivity and heat storage are necessary.

Space and Weight Savings

Because smaller amounts of DynaGuard™ 1600 are needed for thermal management, it is an ideal material for industrial, commercial and modern automotive applications where considerable space and/or weight savings are valuable in increasing capacity or efficiency without sacrificing the thermal performance of the system. This is most notable on pipe systems where the thinnest system keeps the outer surface area increase to a minimum.

High Temperature Capability

DynaGuard™ 1600 systems are designed to meet continuous high temperature environments up to 1,600°F, but are also capable of performing in intermittent exposure to 2,300°F temperatures for fire.

Easy Fabrication

Shapes can be fabricated in the field by various cutting methods, but ThermoDyne also provides a virtually limitless range of custom pre-fabricated and intricate shapes upon request.

Thermal Conductivity Data (Btu-in/hr-ft²-°F)*

DynaGuard™ 1600, 12 lb/ft³

Mean Temp. °F (°C)	Thermal Conductivity
0°F (-17°C)	0.14 (0.020 W/m-K)
500°F (260°C)	0.18 (0.026 W/m-K)
1,000°F (538°C)	0.29 (0.042 W/m-K)
1,500°F (816°C)	0.42 (0.060 W/m-K)

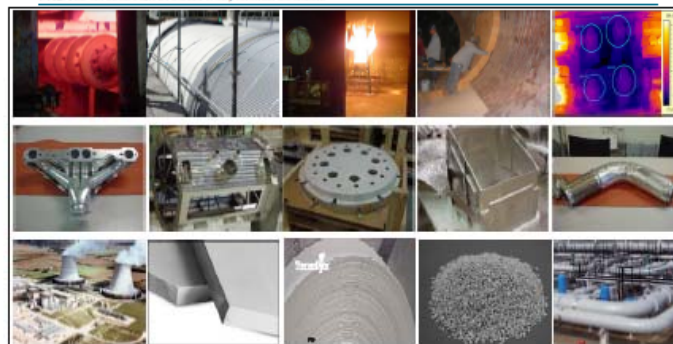
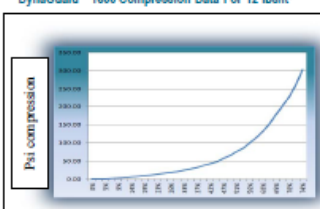
*NOTE: Thermal conductivity values have been measured in accordance with ASTM Test Procedure C-177 using 1" square samples. When comparing similar data, it is advisable to check the validity of all thermal conductivity values and ensure the resulting heat flow calculations are based on the same condition factors. Variations in any of these factors will result in significant differences in the calculated data.

Typical Characteristics

Core Density	12 lb/ft ³ (258 kg/m ³)	others available
Thickness	1/4", 1/2", 5mm, 10mm	others available
Sheet Size	36"x72" (915mmX1830mm)	others available

NOTE: Other non-standard sizes are available in many thicknesses and densities.

DynaGuard™ 1600 Compression Data For 12 lb/ft³



For technical and installation support for DynaGuard™ microporous insulation, please contact ThermoDyne's application engineering team.

DynaGuard™ products offer a variety of solutions for many applications.

Industrial
Power Plants
Petrochemical
Off Shore Top side
Glass Production

Commercial
Lab Furnaces
Solar
Appliances
Night Storage Heaters

Automotive
Exhaust Systems
Interior Shielding
Engine Bay
Diesel Exhaust



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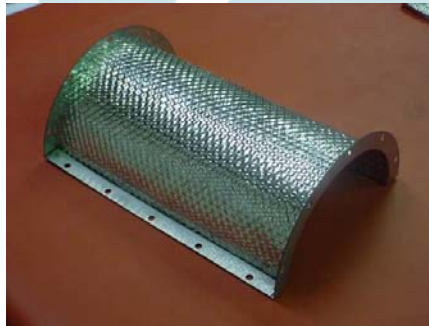
Microporous **Insulation** Product Forms

Fabricated Materials: because applications vary in their requirements, ThermoDyne is easily able to customize its products accordingly.

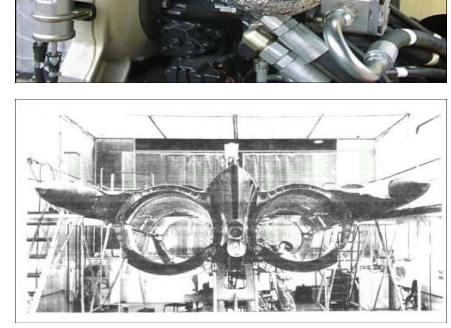
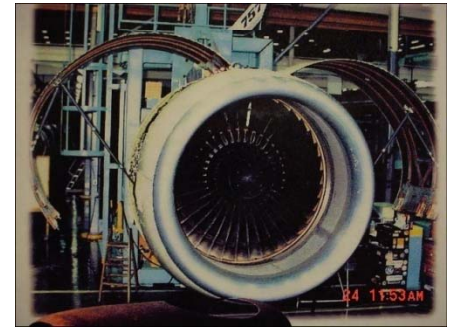


- ThermoDyne is able to encapsulate its microporous materials in a variety of materials, including metal, specialty cloths, and composite systems.
- ThermoDyne is also able to make “formed to shape” pieces for specific applications, and can easily provide custom-fitted or fabricated parts to drawings or descriptions provided by customers.

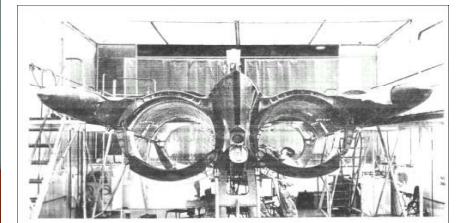
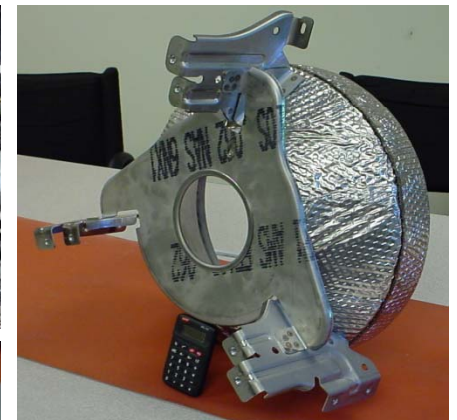
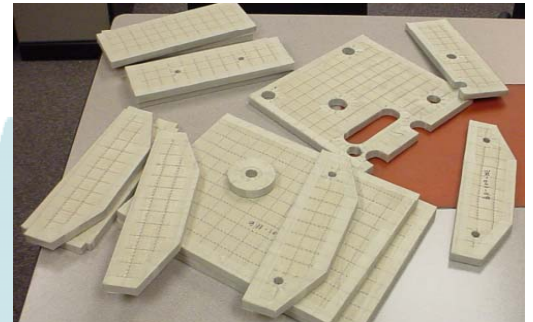
Microporous Insulation Product Forms

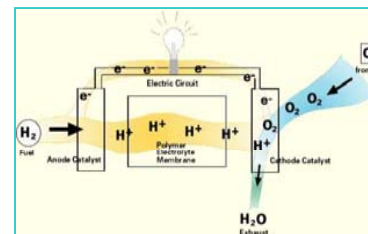


Microporous Insulation Product Forms

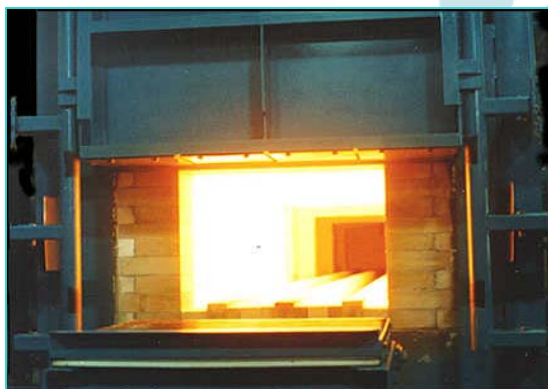


Microporous Insulation Product Forms





Microporous Markets and Applications



Microporous Markets and Applications

❑ Aerospace

- Excelflex® flexible and Excelblok™ rigid microporous systems are currently used in a variety of military/defense and commercial aerospace applications.
- They are ideally suited for the demanding quality structure of most aerospace industry customers, and provide a solution to the always critical issues of space and weight conservation, thermal performance, vibration resistance and material durability.
- Engine nacelles, fire barriers, data recorder insulation, avionics protection, engine shrouds and thrust reversers are but a few of the common applications where microporous materials are commonly used.

Microporous Markets and Applications

□ Industrial

- DynaGuard® microporous systems are currently used in a variety of heavy industrial, molten metal and commercial applications.
- They are ideally suited for the needs of the high performance, price-competitive markets in which they are intended.
- Ladle liners, oven and kiln backup systems, commercial appliance insulators and fuel cells (and fuel cell reformers) are but a few of the common industrial/commercial applications where microporous materials are commonly used.

Microporous Markets and Applications

□ Automotive

- DynaGuard® microporous systems are ideally suited for a variety of commercial and high performance automotive applications.
- They are available in a variety of customized product forms, and can be easily installed and maintained in most application scenarios.
- Exhaust manifolds, engine headers, cockpit and floorboard insulators and turbo-charger insulation systems are but a few of the applications where microporous materials are most commonly used.

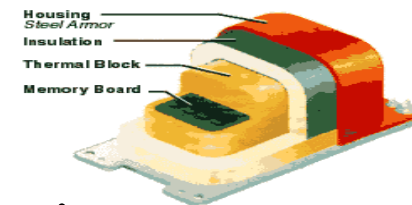
Microporous Markets and Applications

□ Fuel Cells

- DynaGuard® microporous systems are currently used in a variety of commercial and automotive fuel cells and fuel cell reformers.
- They are easily adaptable to the continuing changes and needs associated with the R&D efforts currently underway to produce the next generation of energy-efficient fuel cell systems.
- SOFC Fuel Cell stack insulators, PEM automotive and commercial fuel cell reformer units are but a few of the fuel cell applications where microporous materials are currently being used.

Deployable Recorders

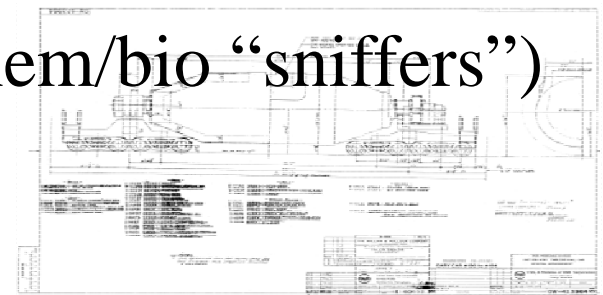
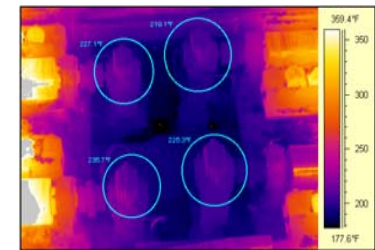
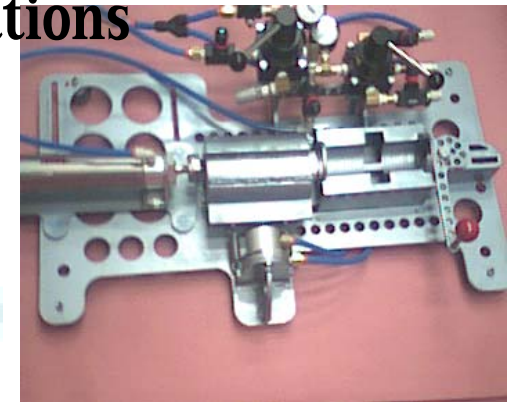
Some military aircraft carry recorders that can be ejected so they land safely away from exploding weapons.



Thermo Dyne Markets and Applications

Additional Specialty Markets

- Nuclear Power (NRC guide 1.36)
- Nuclear/Hazardous Waste Disposal
- Railway
- Agriculture, Mining and Construction Equipment
- Security (Explosives detectors, Chem/bio “sniffers”)
- Flight Data Recorders



Conclusions

- ✓ ThermoDyne insulation materials and insulation systems solve the intensive demands of thermal performance, temperature, space, weight, fabrication intricacy, and environment requirements.
- ✓ ThermoDyne continually and successfully seeks to provide custom and engineered solutions for high performance applications across a wide variety of industries and markets.
- ✓ ThermoDyne manufactures both standard and customized microporous product forms to meet the specific needs of individual customer applications and requirements.
- ✓ ThermoDyne is capable of providing exemplary experienced technical and applications support for virtually any high temperature scenario, as well as specific studies on heat flow, material performance and estimated return on investment for the material or system proposed.



