

Reduction of Energy Usage Through Insulation Selection & Design

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Morgan Thermal Ceramics

New Insulation Options

- Microporous Insulation
 - History and Theory
- RFC, Bio-Persistence, EH&S and Regulation
 - Superwool Alternatives

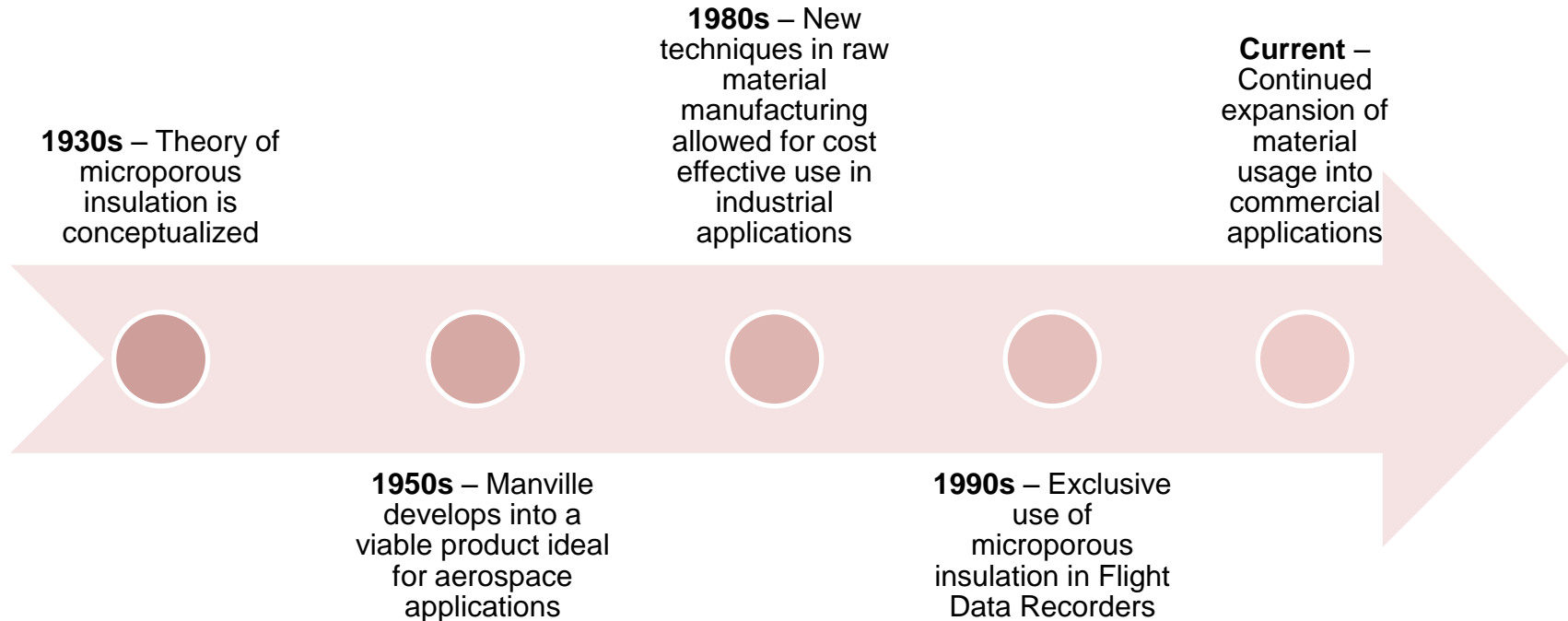
Insulation Design Techniques

- Material Selection

Microporous Insulation

Theory and Application

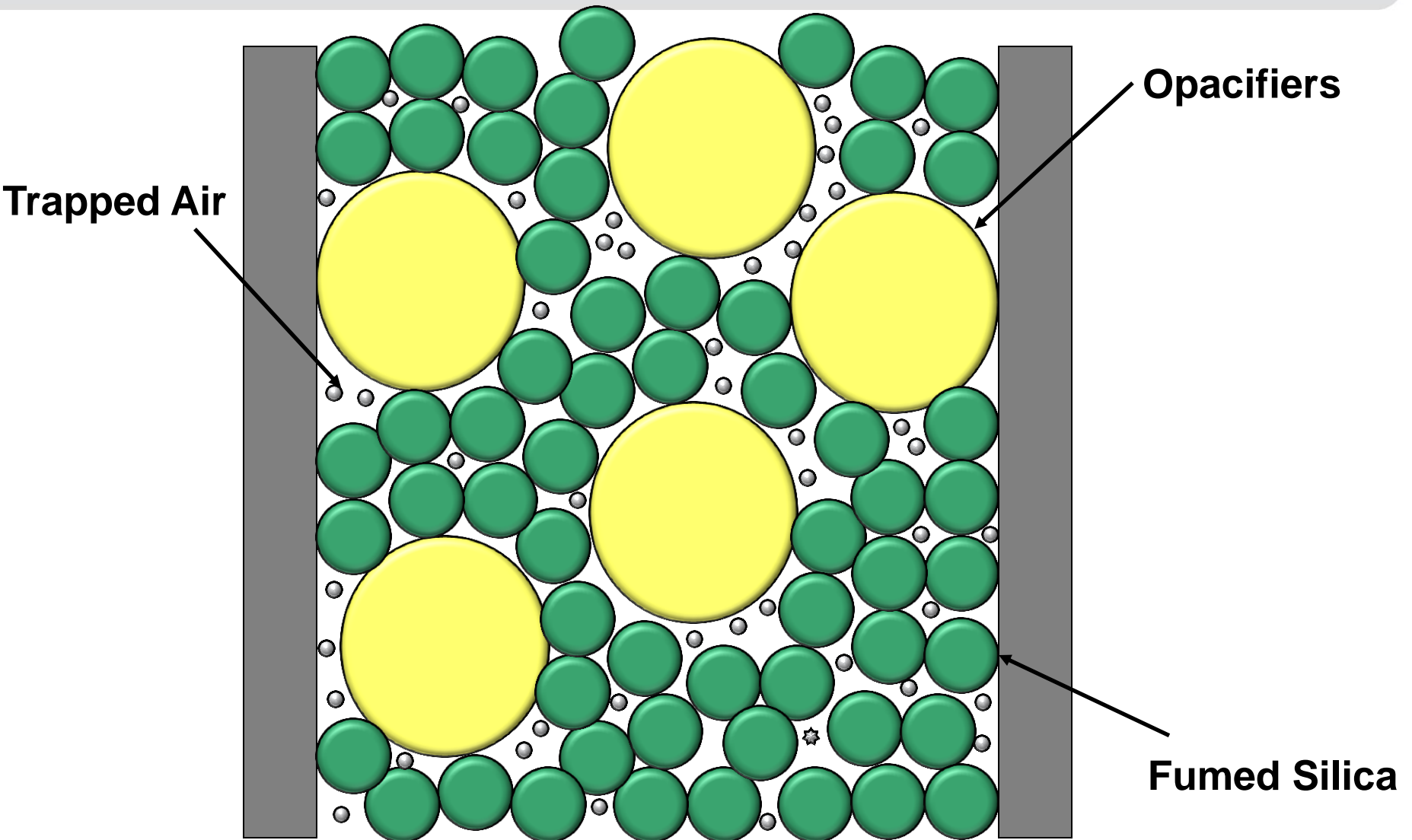
A “New” Type Insulation



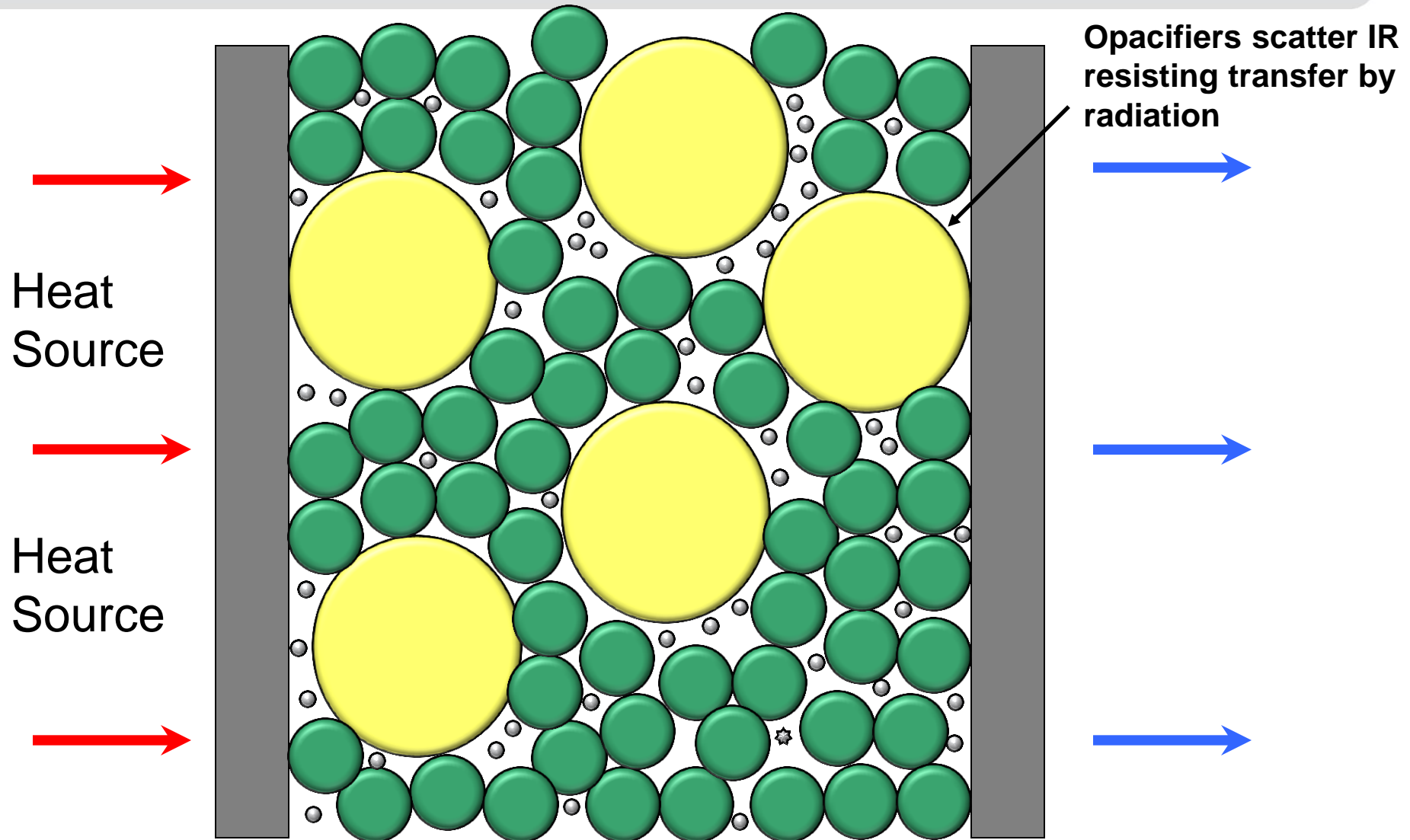
What is microporous insulation?

- A low density powder comprised of heat resistant particles (metal oxides / inorganic opacifiers) and high temperature fibers compressed to form a microporous structure
 - See ASTM C1676-08 for detailed information
- Most efficient insulation commercially available that controls all three modes of heat transfer
 - Radiation
 - Conduction
 - Convection

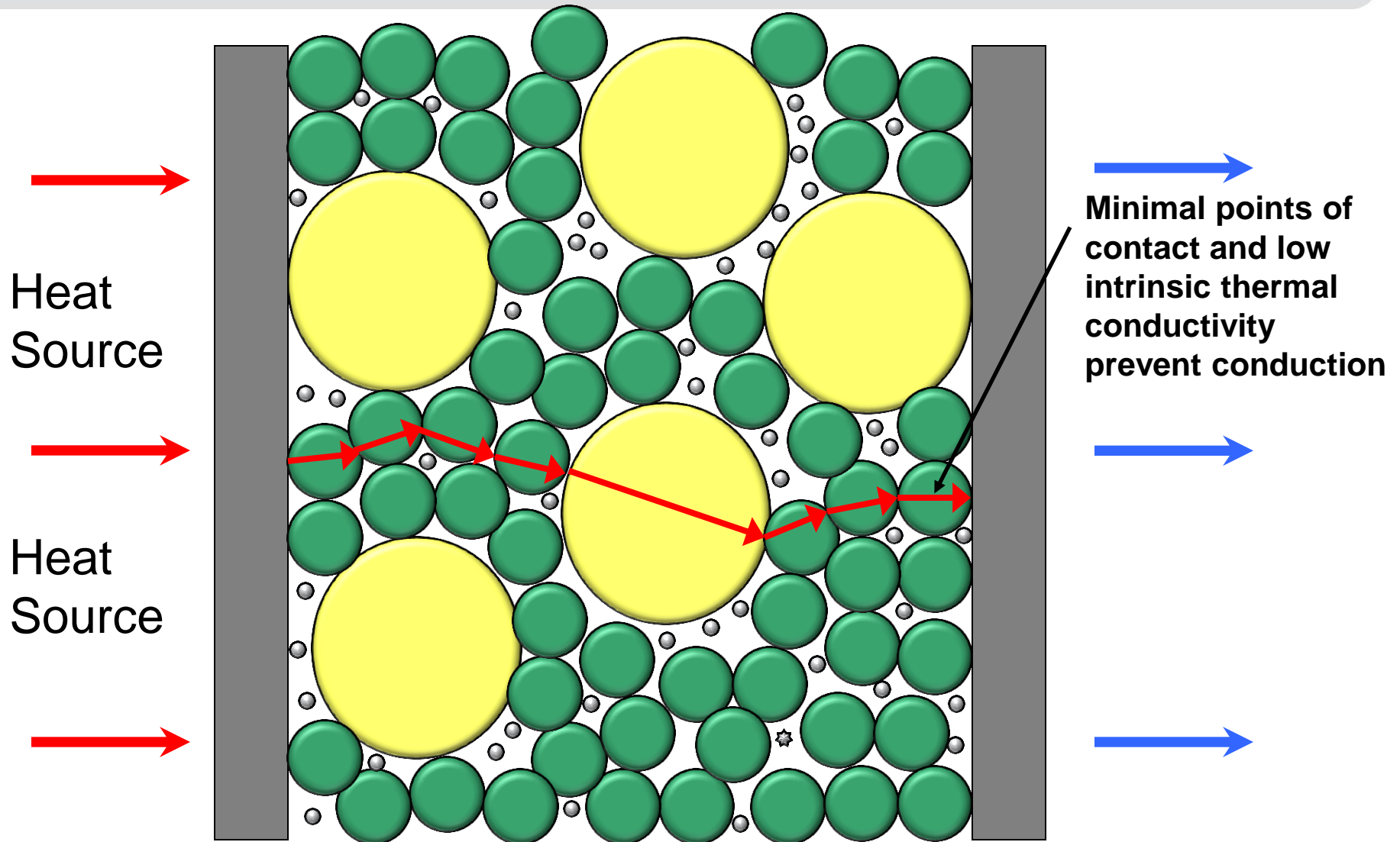
Microporous Insulation



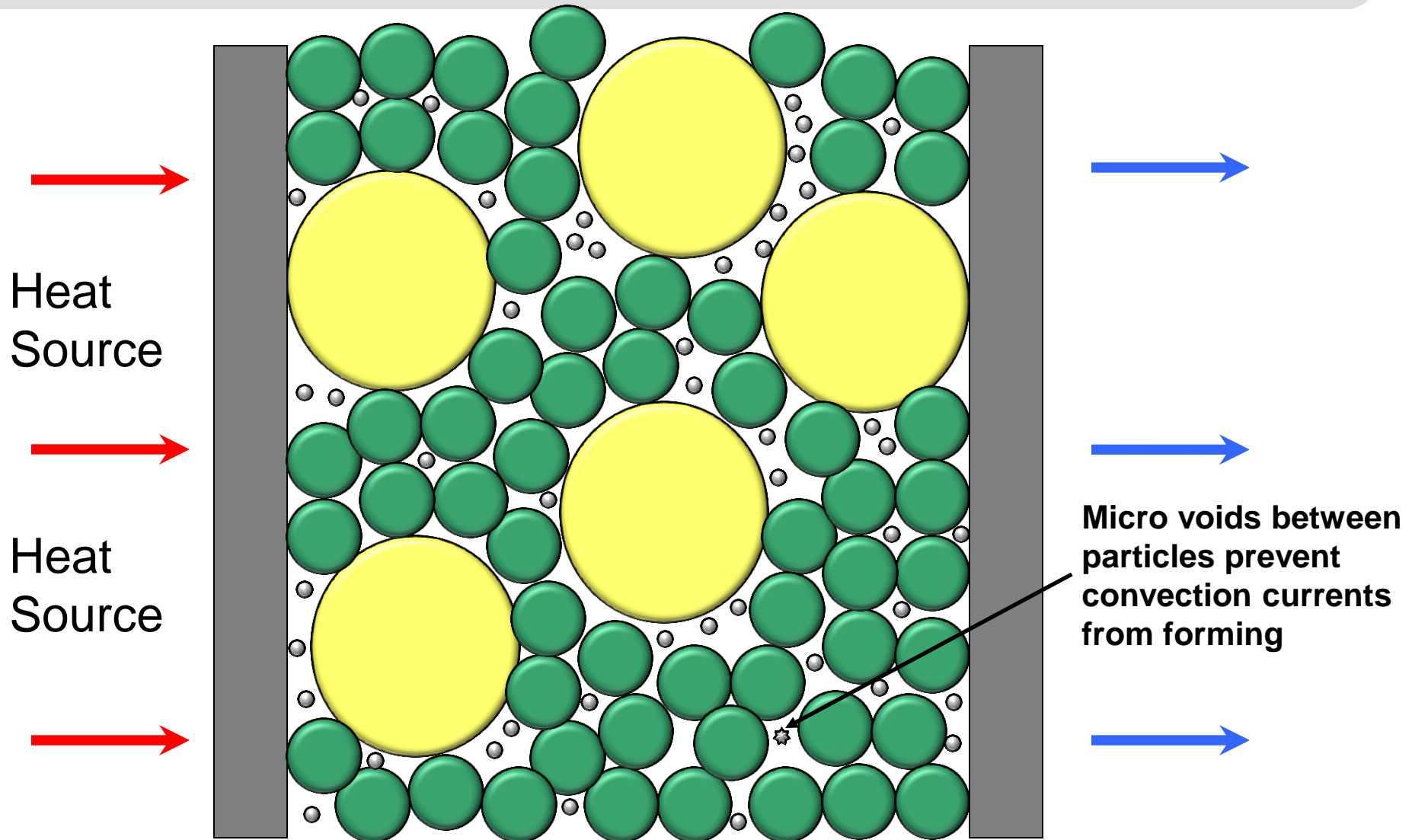
Microporous Insulation



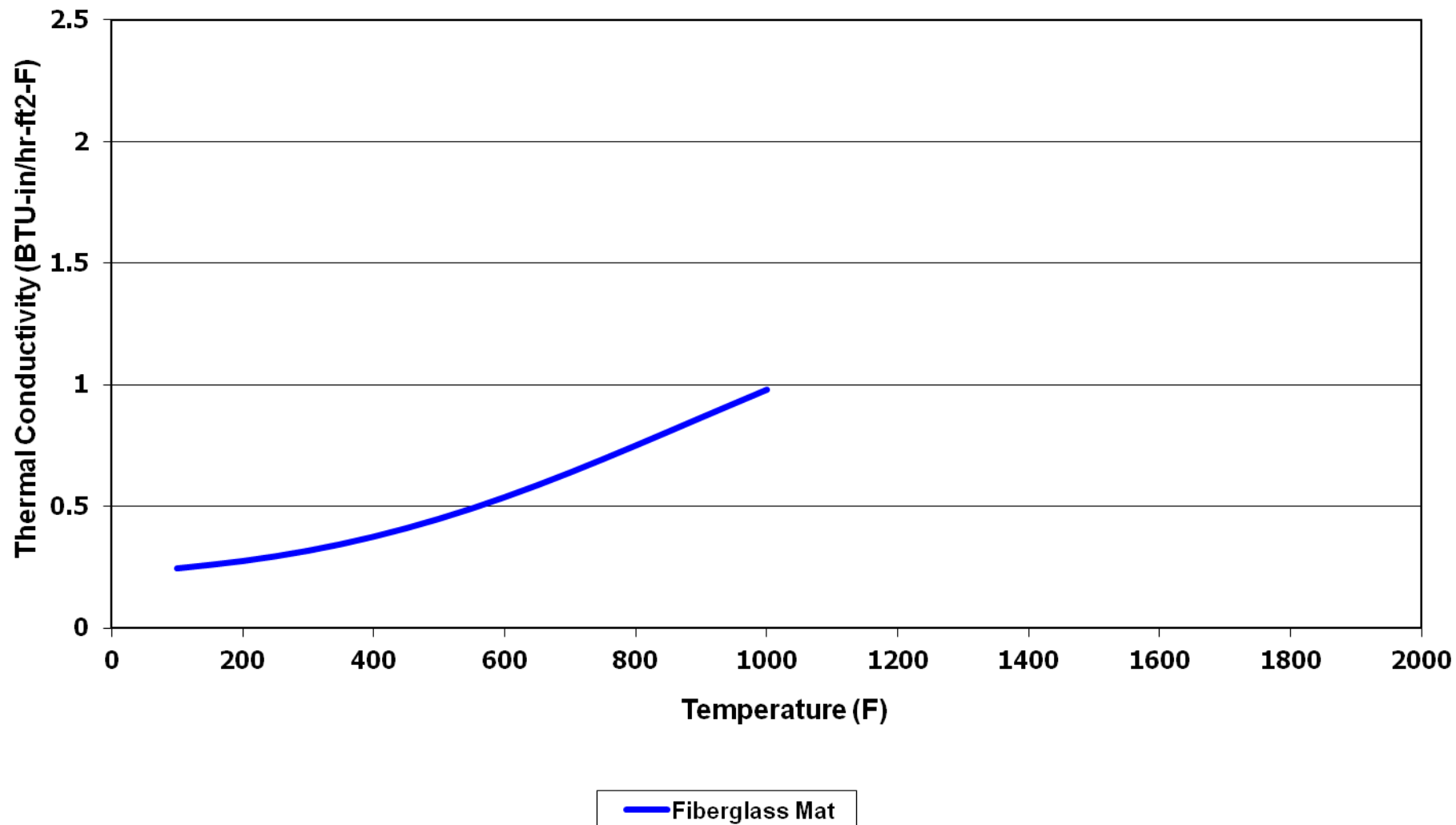
Microporous Insulation



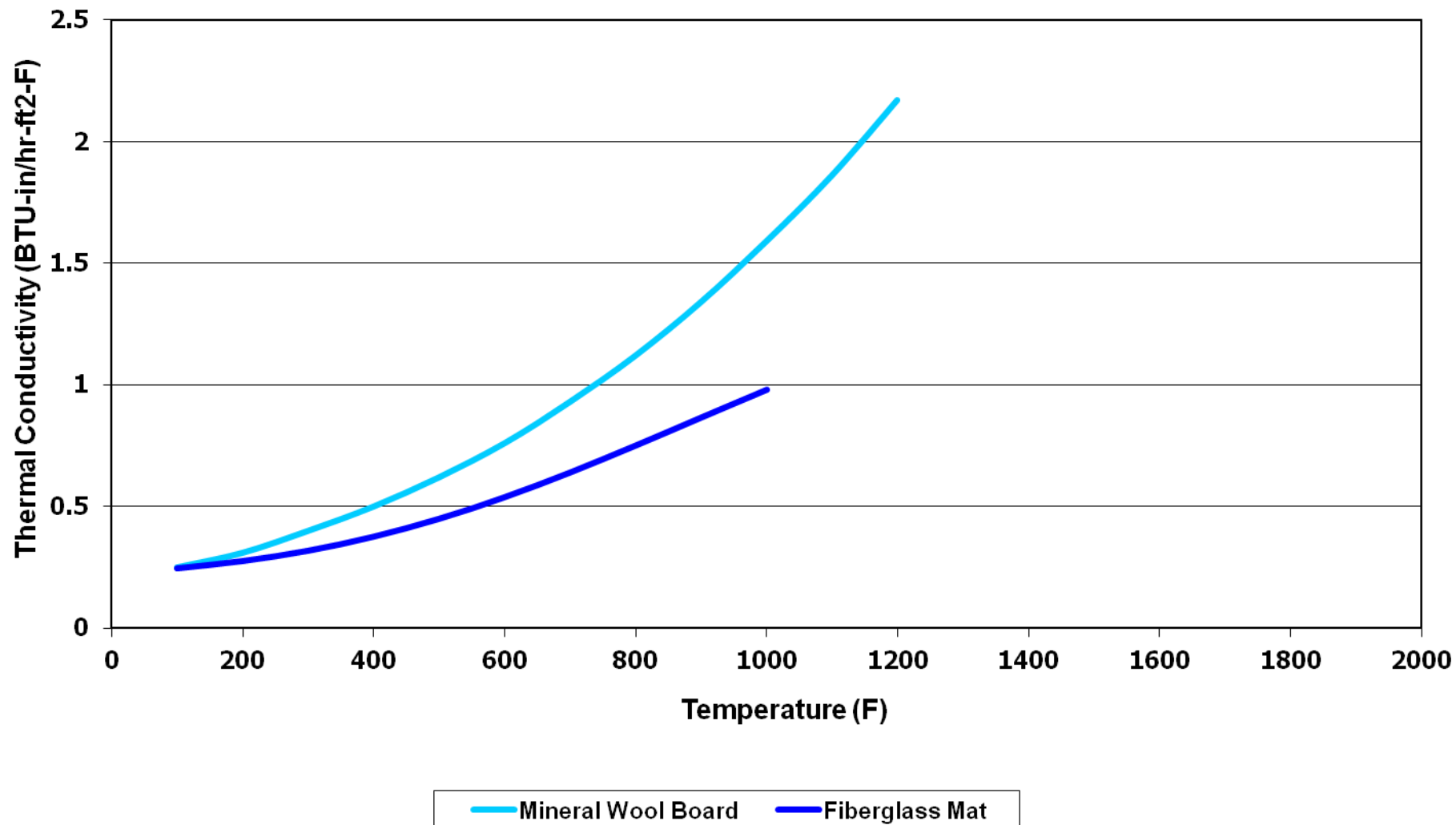
Microporous Insulation



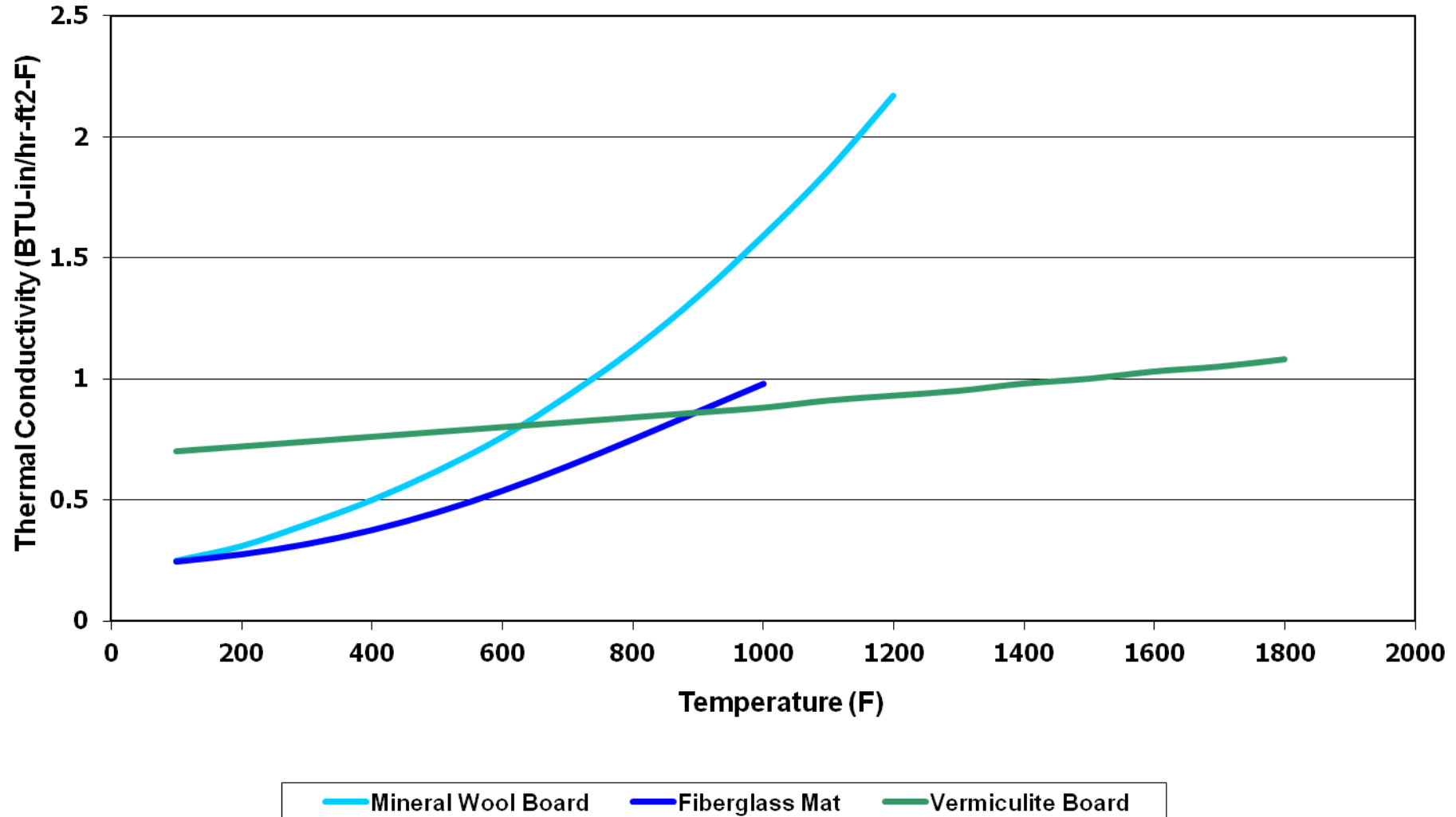
Thermal Conductivity



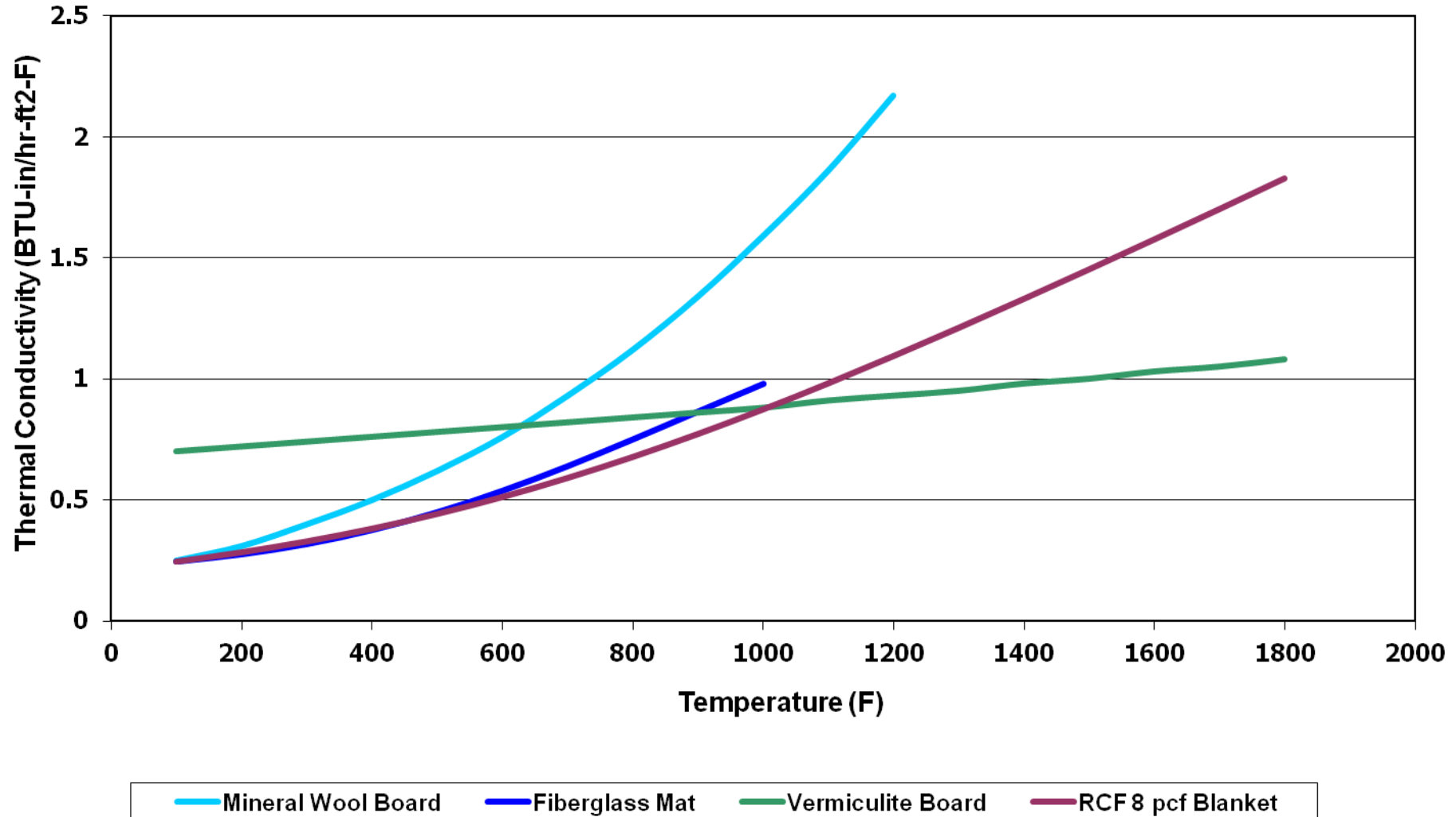
Thermal Conductivity



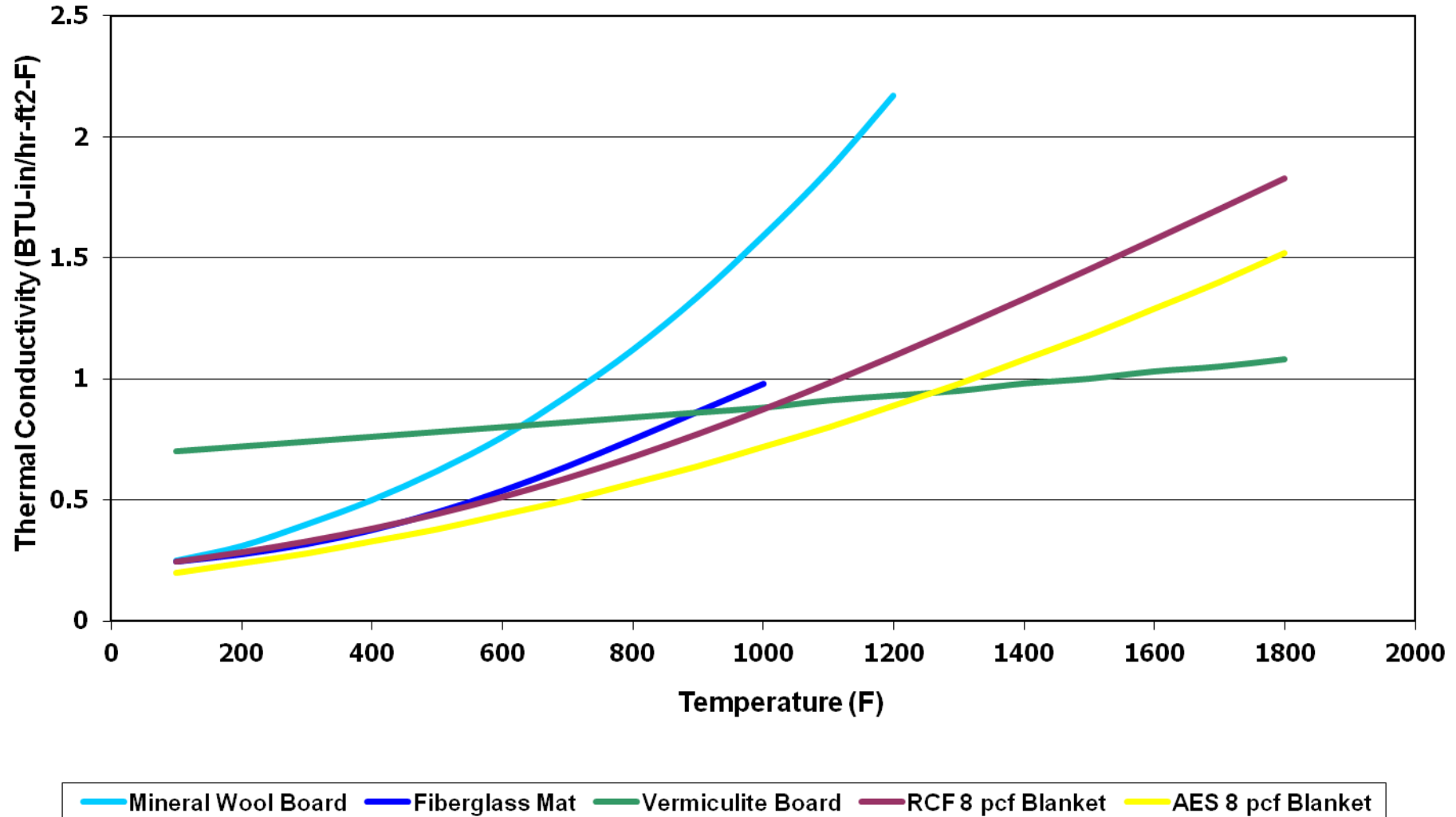
Thermal Conductivity



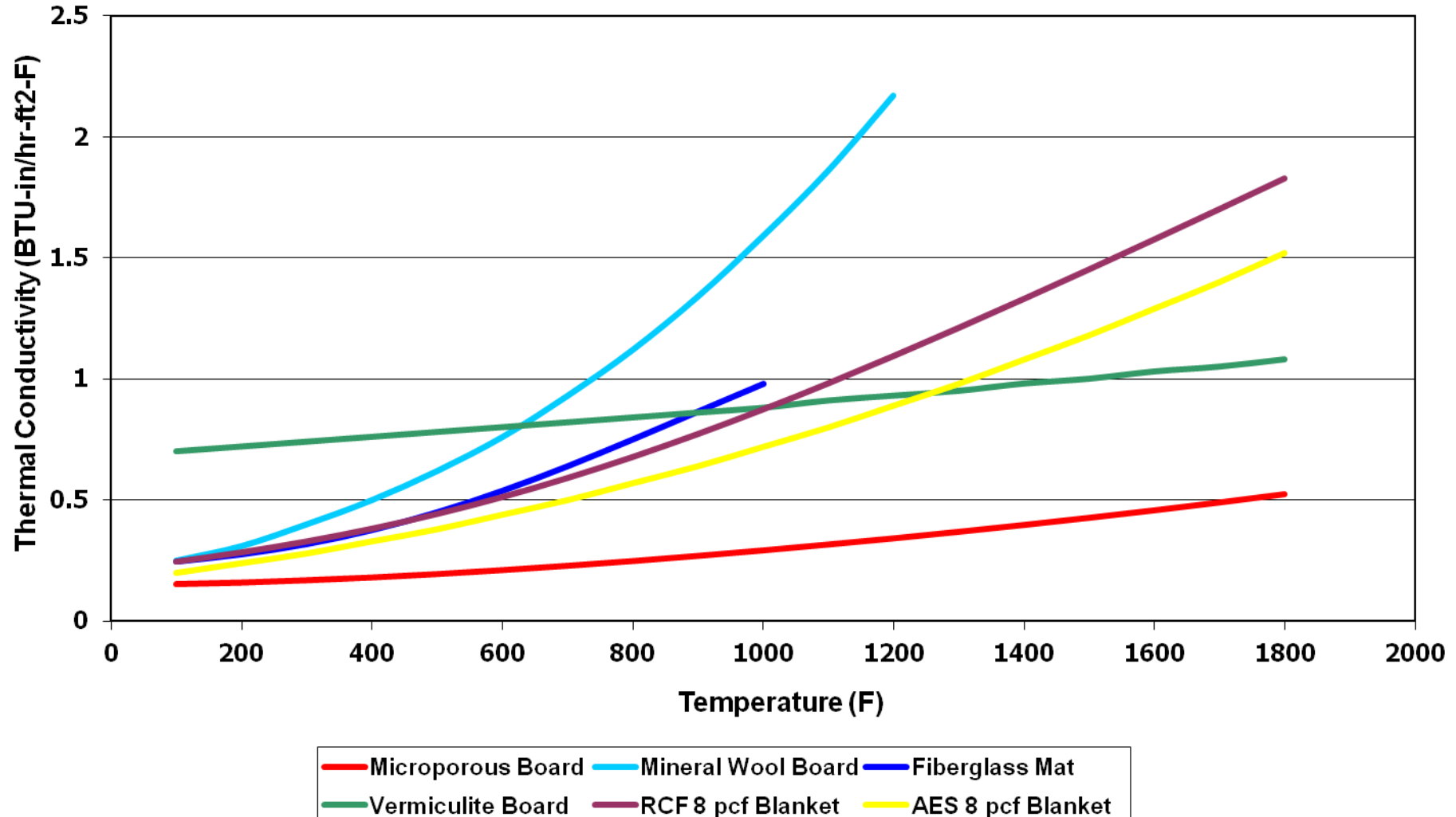
Thermal Conductivity



Thermal Conductivity



Thermal Conductivity

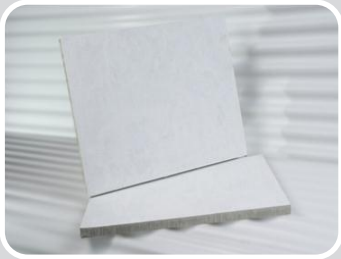


Typical Product Types



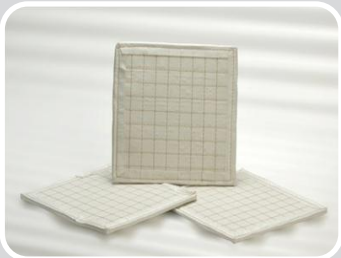
Board

- Rigid material encapsulated in thin plastic
- Lowest thermal conductivity of all product types



Panel

- Core material encapsulated in high temperature cloth
- Lower dust than board



Flexible

- Core material encapsulated in high temperature cloth and quilted
- Flexible for round or contoured shapes

Mechanical Properties

Temperature Use Limit

- Core always good up to 1800 F
- Standard cloth has a lower temperature rating
 - Cloth can be sacrificial depending on application

Compression Resistance

- Dependent on density
- Similar to vermiculite board

Shrinkage

- Less than 1% up to 1700 F
- Approximately 3% at 1800 F

RCF and Superwool

Review and Introduction to Superwool Plus and HT

TC's commitment to a healthy environment

- Increasing concern over the health effects relating to RCF has caused Thermal Ceramics to develop alternative fibre products, these come under the brand name “Superwool®”.
- TC has been proactive in studying the health aspects of RCF for more than 20 years.
- TC has helped to lead the work in the USA and in the EU in the fields of:
 - Epidemiological (human) studies
 - Toxicological (animal and *in vitro*) studies
- The studies have been carried by independent scientists and organisations and are used as references by regulators.

Why are regulators concerned about RCF?

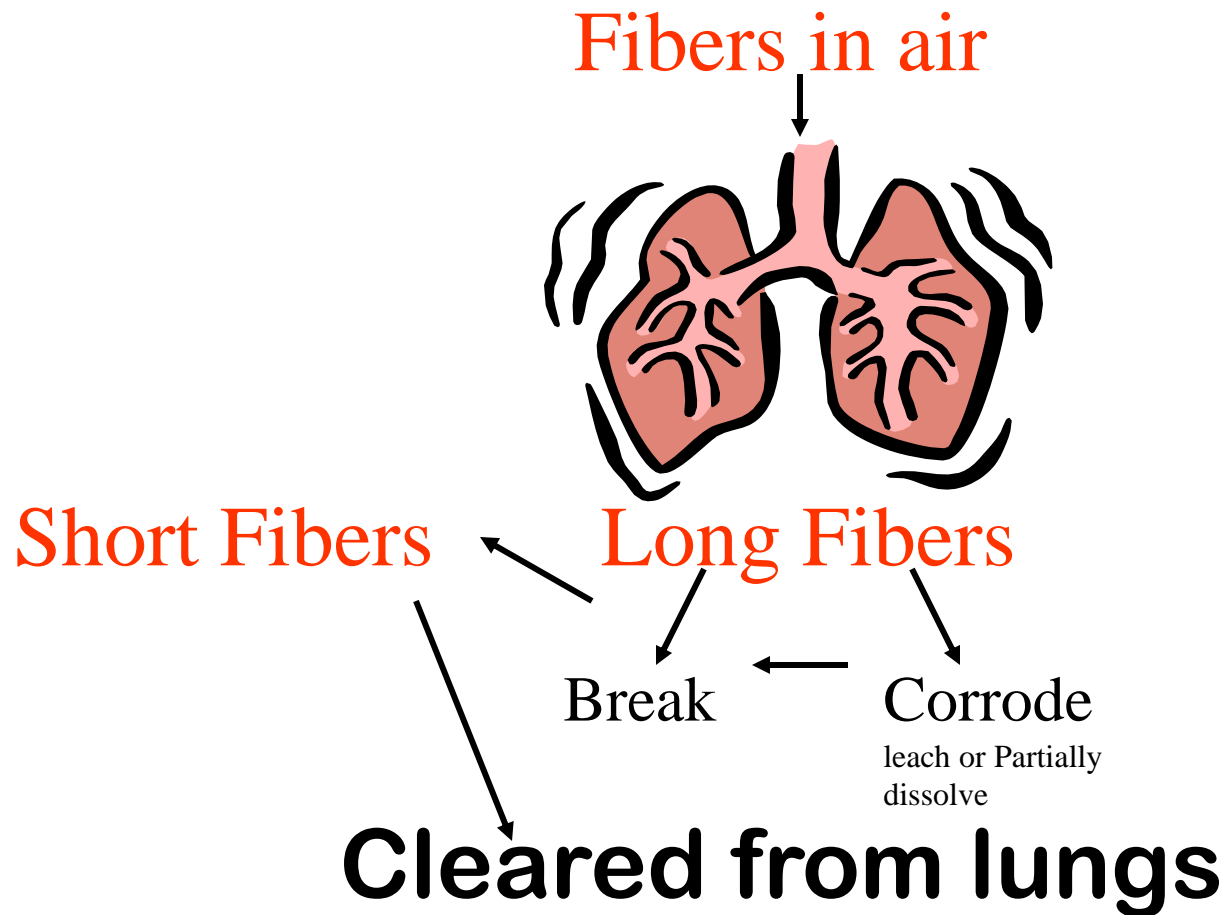
- History shows that fine asbestos fibres inhaled into the lungs may cause cancer.
- RCF is not asbestos.
- However, RCF has a higher biopersistence than most glass wools and mineral wools.
- Animal testing of RCF in the early 1990s showed signs of carcinogenicity.
- Human epidemiology has shown
 - reduction in lung function among smokers exposed to RCF.
 - a correlation between pleural plaque development and cumulative RCF exposure

What is BIO-PERSISTENCE?

Bio-Persistence

- **Definition**: The ability of fibers to resist removal from the lungs by natural mechanisms (i.e., dissolution and breakage).
- **How Measured?**: It is measured by the time it takes for half of the fibers induced to disappear from the lungs.

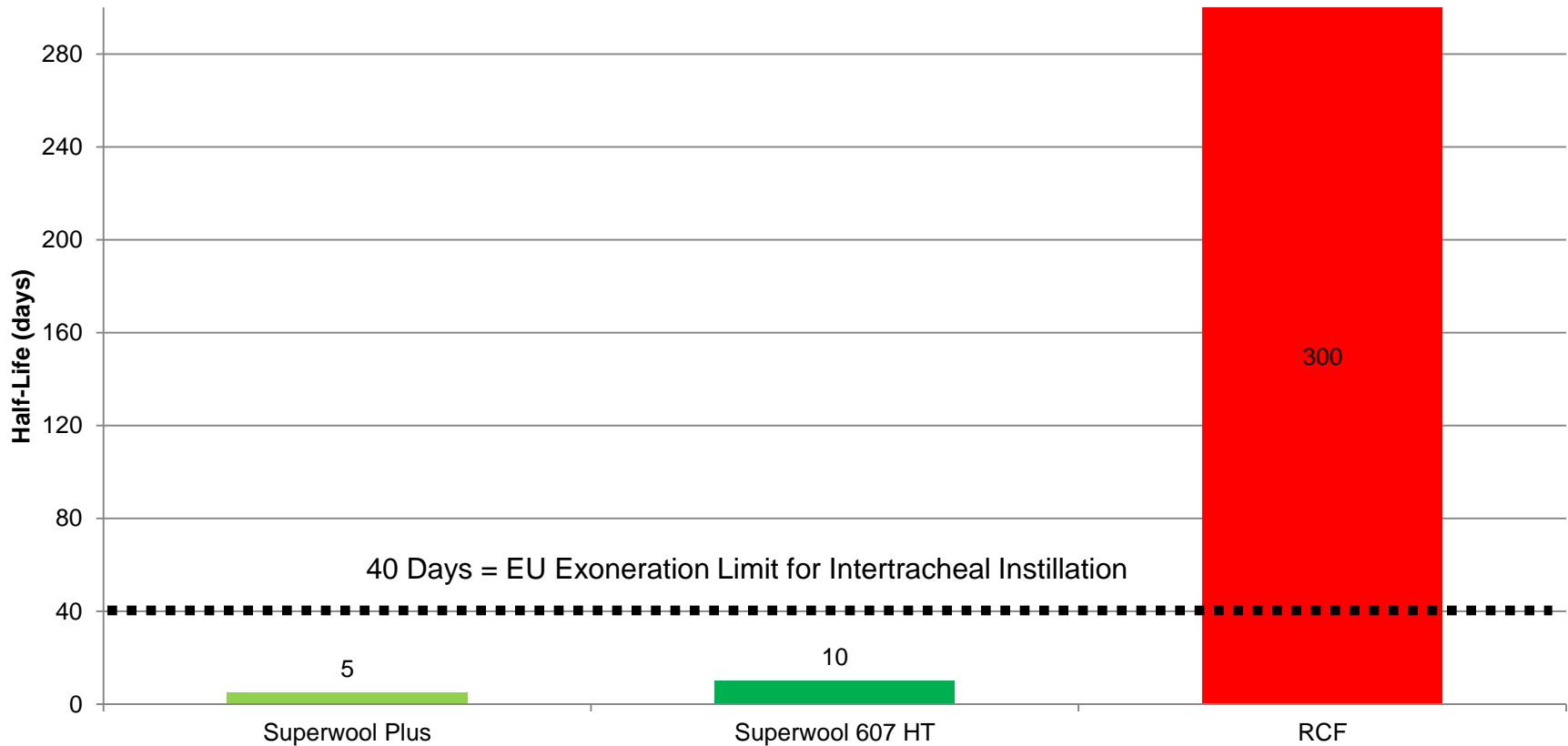
Low Bio-Persistence means less Bio-Accumulation



Short fibers and fragments, whether inhaled or produced by breaking long fibres, are cleared from the lungs like other dusts encountered in everyday life.

Bio-Persistence Results

Half Life of Various HTIW via Intertracheal Instillation (1)



(1.) Source: Biopersistence by Intertracheal Instillation from Fraunhofer Reports For Superwool and from BIA-Report for RCF: (2/98: Fasern - Tests zur Abschätzung der Biobestaändigkeit und zum Verstaubungsverhalten)

RCF Regulation by Country

	Stance on RCF		
	European Union	Canada	United States
Permissible or Recommended Exposure Limit (PEL or REL)	<ul style="list-style-type: none"> • 0.1 to 1.0 fibers/cc • PEL is typically <u>mandatory</u> 	<ul style="list-style-type: none"> • 0.2 to 1.0 f/cc <u>mandatory</u> PEL (Canada) Examples for Canada: • 0.5 f/cc PEL (Ontario, CN) • 0.2 f/cc PEL (British Columbia and Alberta, CN) 	<ul style="list-style-type: none"> • 0.5 f/cc <u>voluntary</u> REL (U.S.) • 0.2 f/cc <u>mandatory</u>, Regulated in California, August 3, 2010
RCF's Status	<ul style="list-style-type: none"> • Class 2 Carcinogen 	<ul style="list-style-type: none"> • Possible Carcinogen 	<ul style="list-style-type: none"> • Possible Carcinogen
Regulatory Control	<p>All aspects of RCF use are controlled by regulation including:</p> <ul style="list-style-type: none"> • Workplace cleanliness, • Disposal • Obligation to use alternatives if possible 	<ul style="list-style-type: none"> • Regulated 	<ul style="list-style-type: none"> • Not regulated in U.S. • <u>Exception:</u> As of August 2010, Cal OSHA regulated PEL of 0.2 f/cc for RCF

Superwool® Regulation by Country

	Stance on Superwool	
	European Union (EU)	United States and Canada
Classification of Superwool Family	<ul style="list-style-type: none"> • Alkaline Earth Silicate (AES) • Not RCF 	<ul style="list-style-type: none"> • Alkaline Earth Silicate (AES) • Not RCF
Superwool Status	<ul style="list-style-type: none"> • Fully exonerated from any carcinogen classification in the European Union under the Provisions of Directive 97/69/EC 	<ul style="list-style-type: none"> • Viewed as a nuisance dust • May cause temporary, mild mechanical irritation to the eyes, skin, nose and/or throat
PEL/Regulatory Control	<ul style="list-style-type: none"> • No PEL • Not Regulated 	<ul style="list-style-type: none"> • No PEL • Not Regulated

The Superwool Family of Products are Alkaline Earth Silicate (AES) fibers; Not RCF

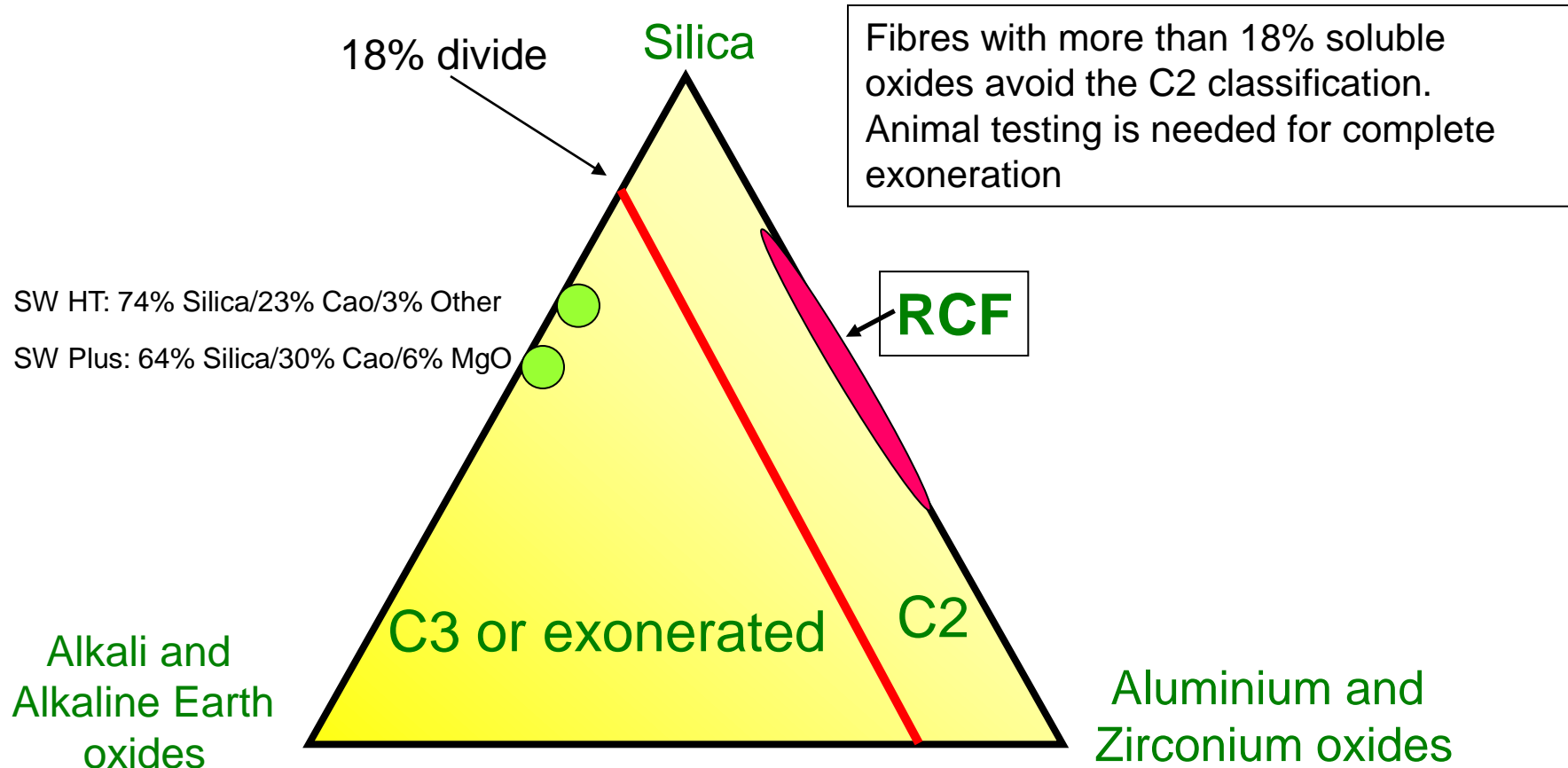
RCF Alternatives

Superwool Plus and Superwool HT

Superwool – why it is an alternative to RCF?

- Man-made vitreous silicate fibres (MMVF) containing >18% alkali and alkaline earth oxides are classified as Carcinogen 3 in Europe.
- These fibres may be exonerated from classification as a carcinogen if one of the specific criteria described under nota Q of Directive 97/69/EC are met.
 - The animal tests at RCC which lead to the classification of RCF also included X607; however animals exposed to X607 did not develop excess tumours. This fulfils the exoneration criteria under Nota Q.
 - Superwools have shown <40 days half-life in IT tests on rats which also provides complete exoneration under Nota Q.
- **This European regulation is the only official system that exonerates MMVFs (including Superwools) from classification as carcinogens .**

RCF and Superwool on a chart showing the EU 18% oxides rule for vitreous silica fibres



Superwool® Plus and RCF

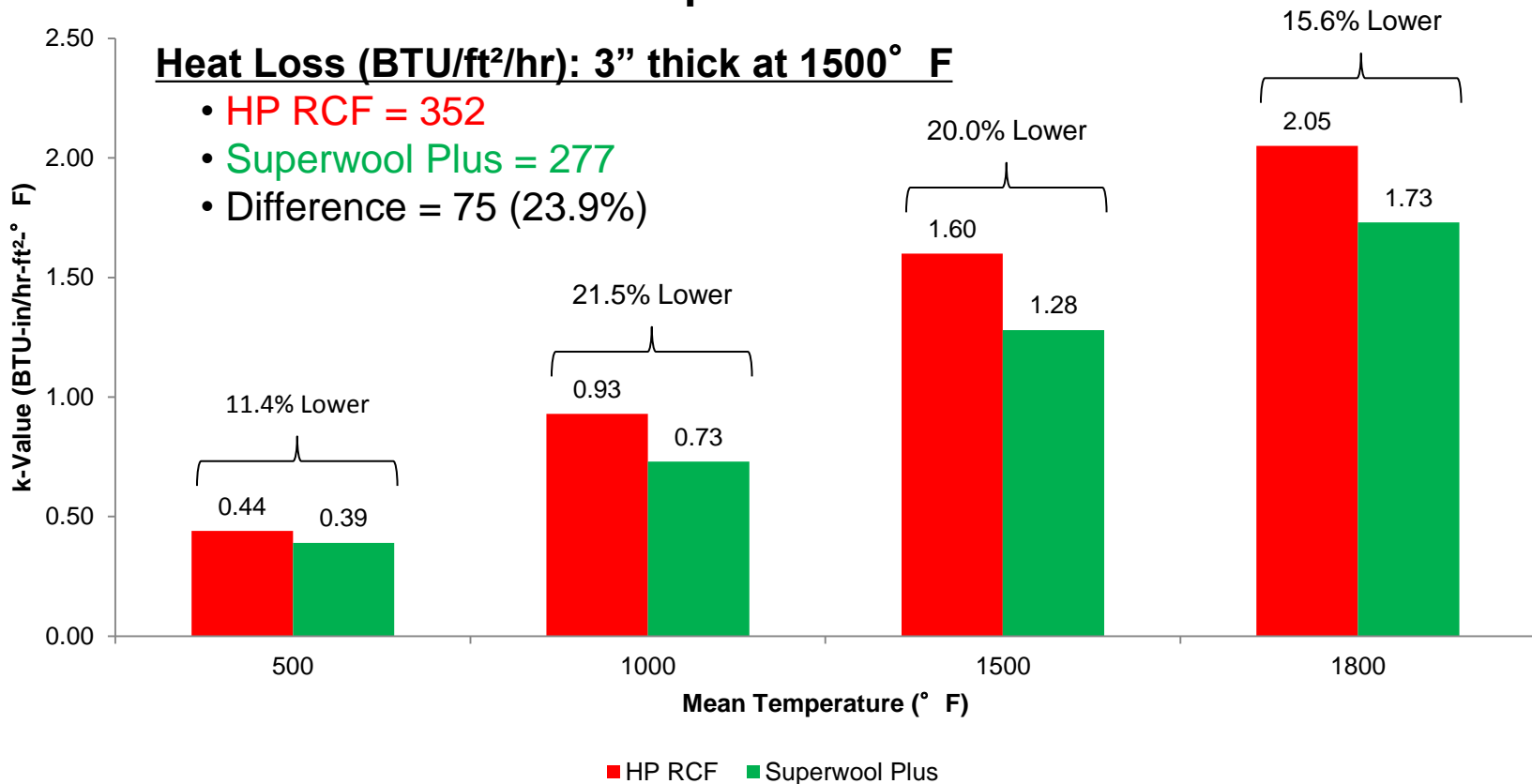
Property Comparison of Superwool Plus vs. RCF Blanket			
		HP RCF	Superwool Plus
Continuous Use Temperature Limit (° F)		2150	1832
Classification Temperature Limit (° F)		2400	2192
Thermal Conductivity (BTU-in/hr-ft ² -° F) 8 lb/ft ³ Blanket	@ 1000° F	0.93	0.73
	@ 1800° F	2.05	1.73
	@ 2100° F	2.49	Beyond Continuous Temp Use Limit
Over Temperature Cushion		Higher	Lower
Bio-Persistence, Half-Life (days)		50	≤ 10

Key Advantages of Superwool Plus over HP RCF:

- Low Bio-Persistence
- Low Shrinkage up to Classification Temperature
- Low Thermal Conductivity

Thermal Conductivity – vs. HP RCF

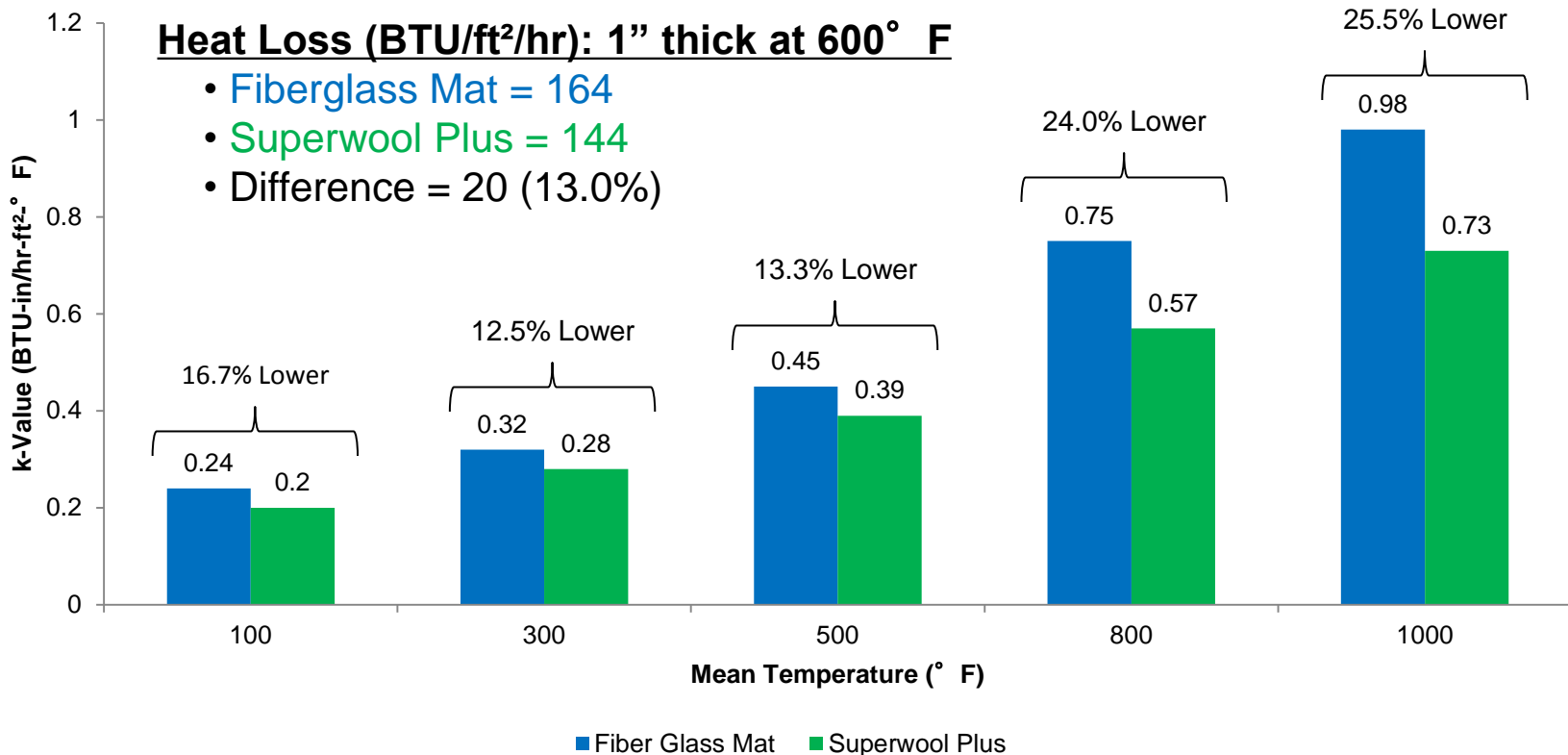
Thermal Conductivity (ASTM C-201) HP RCF 8 lb/ft³ vs. Superwool Plus 8 lb/ft³ Blankets



Superwool® Plus 8 lb/ft³ blanket has a thermal conductivity that is more than 15% lower than HP RCF 8 lb/ft³ blanket at mean temps >800° F

Thermal Conductivity – vs. Fiberglass Mat

Thermal Conductivity (ASTM C-201) Fiberglass Mat vs. Superwool Plus 8 lb/ft³ Blanket



Superwool® Plus 8 lb/ft³ blanket has a thermal conductivity that can be significantly lower than Fiberglass Mat and is binder-free

Superwool® 607® HT

Key Characteristics of Superwool 607 HT ⁽¹⁾

Low Biopersistence

- First low biopersistent fiber with a classification temperature of 2372°F (1300°C)
- Disposable in standard landfills

Excellent Physical Properties

- Lowest shrinkage of any comparable insulation up to its classification temperature
- Continuous use temp of 2102 to 2300°F (1150 to 1260°C) depending on product
- Short-term exposure limit that is 90°F (50°C) higher than standard RCF

Proven Track Record

- In use in Europe since the end of 2005
- Proven⁽²⁾ reliability for applications such as:
 - wall boilers
 - tunnel kilns
 - glass pre-heating furnaces
 - mold wrap for steel industry

⁽¹⁾ Available in blanket, paper, board, bulk, modules, mastics and vacuum formed shapes

⁽²⁾ As demonstrated in Europe and/or U.S. sales trial

Superwool® 607® HT vs. HP RCF

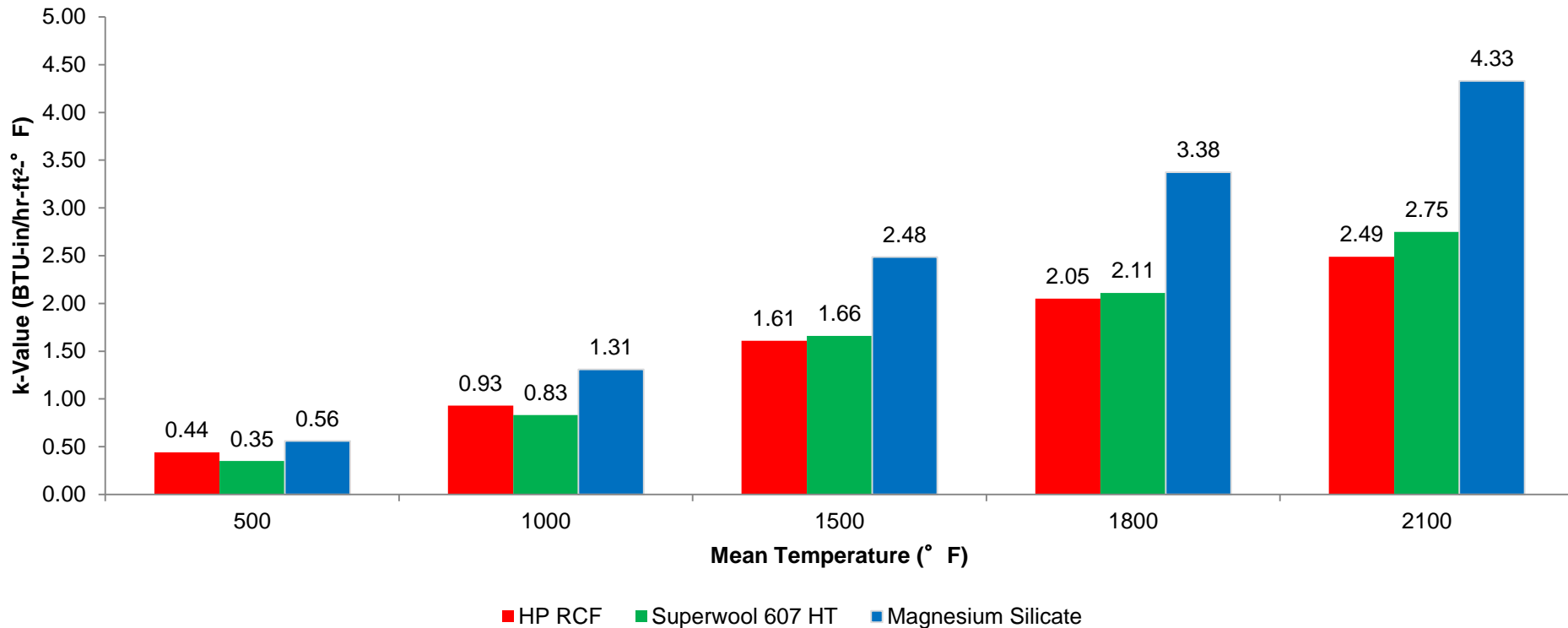
Property Comparison of Superwool 607 HT vs. HP RCF Blanket			
		HP RCF	Superwool 607 HT
Continuous Use Temperature Limit (° F)		2150	2102
Classification Temperature Limit (° F)		2400	2372
Thermal Conductivity (BTU-in/hr-ft ² -° F) 8 lb/ft ³ Blanket	@ 1000° F	0.93	0.83
	@ 1800° F	2.05	2.11
	@ 2100° F	2.49	2.75
Over Temperature Cushion		Higher	Lower
Bio-Persistence, Half-Life (days)		50	≤ 10

Key Advantages of Superwool 607 HT over HP RCF:

- Low Bio-Persistence
- Low Shrinkage up to Classification Temperature

Thermal Conductivity

Thermal Conductivity (ASTM C-201) HP RCF vs. Superwool® 607® HT vs. Magnesium Silicate 8 lb/ft³ Blanket



Energy Savings Through Insulation Selection and Design

How to use the “new” insulation types

Typical Selection Criteria

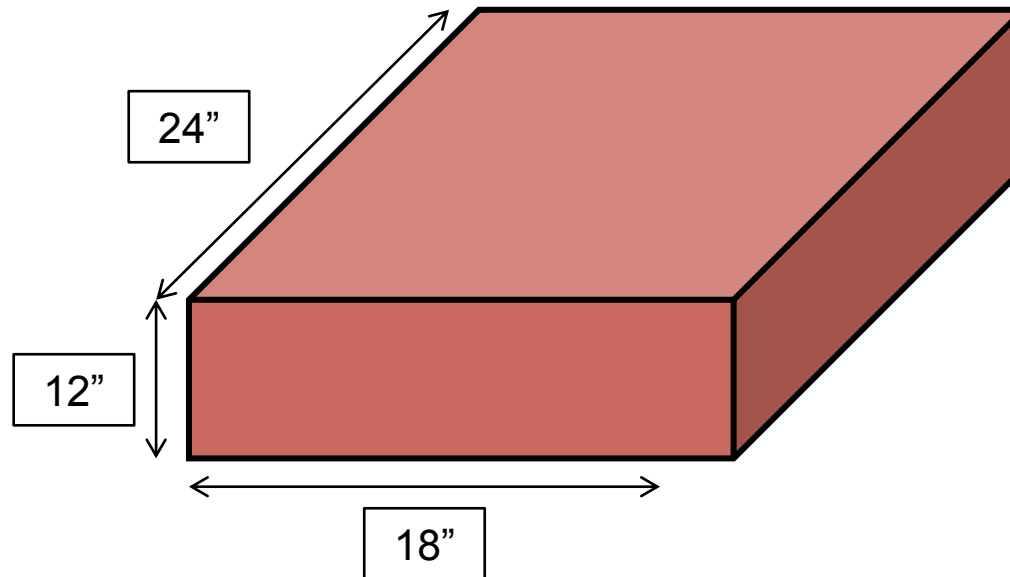
- Thermal Efficiency
- Space Constraints
- Maximum Use Temperature
- Durability
- Ease of Fabrication
- Fire Situations
- Cost
 - Short Term *and* Long Term

Thermal Efficiency

- Regulations and consumer market push for more energy efficient designs
 - New regulations outlining energy efficiency requirements
 - CA and FL leading the nation
 - Market also demanding more energy efficient solutions
- How to meet this demand?
 - Use more efficient insulation materials

Theoretical Case Study – Heater Box

- Standard water heater box for pool / spa application
- Gas Firing Box
- Water Coils Above
- Flame temps at 2000°F



Theoretical Case Study – Heater Box

Current Style Designs

- 1.5" RCF Board
- Outer Temperature - 384°F
- Heat Loss - 1015 BTU / SF / Hr

Optional Design 1" SW HT / 0.5" BTU Board

- Outer Temperature - 274°F
- Heat Loss - 536 BTU / SF / Hr
- Energy Savings ~\$90 annually

Optional Design 0.5" SW HT / 0.25" BTU Board

- Outer Temperature - 374°F
- Heat Loss - 993 BTU / SF / Hr
- Energy Savings - None

Optional Design 0.75" SW HT / .75" BTU Board

- Outer Temperature - 244°F
- Heat Loss - 427 BTU / SF / Hr
- Energy Savings ~\$165 annually

Half the thickness
for the same
insulating
properties

Over twice as
efficient as
standard design

Options

Limitless Options

- Multiple options exist with these types of insulation to add value to your products and reduce the energy usage of the heater units

Energy Usage

- Reduce energy loss through the insulation lining
- Reduce energy usage by lowering set point temperatures

Space

- Reduce the unit footprint by lowering the thickness requirement of the insulation lining

Items to Consider

These material are options to aid in design

- Another tool for your designs

The larger the area, the larger the impact

- Larger Boilers will have more annual savings

Understand the materials and environment

- Not every material type is appropriate for every situation

Ask for assistance

- There are multiple experts in insulation materials that can assist

Don't let insulation be the energy drag in your systems

- Options are available to allow for maximum efficiency!

QUESTIONS??

- ***Thanks for your attention***
- The information presented in this presentation (and all documents linked) can be confidential and legally protected. They are exclusively for the present audience or readers to whom it has been presented.
- All the properties given are typical values and should not be considered as a specification.

Thank you