

## Aerogel-Based Insulation for Industrial Steam Distribution Systems

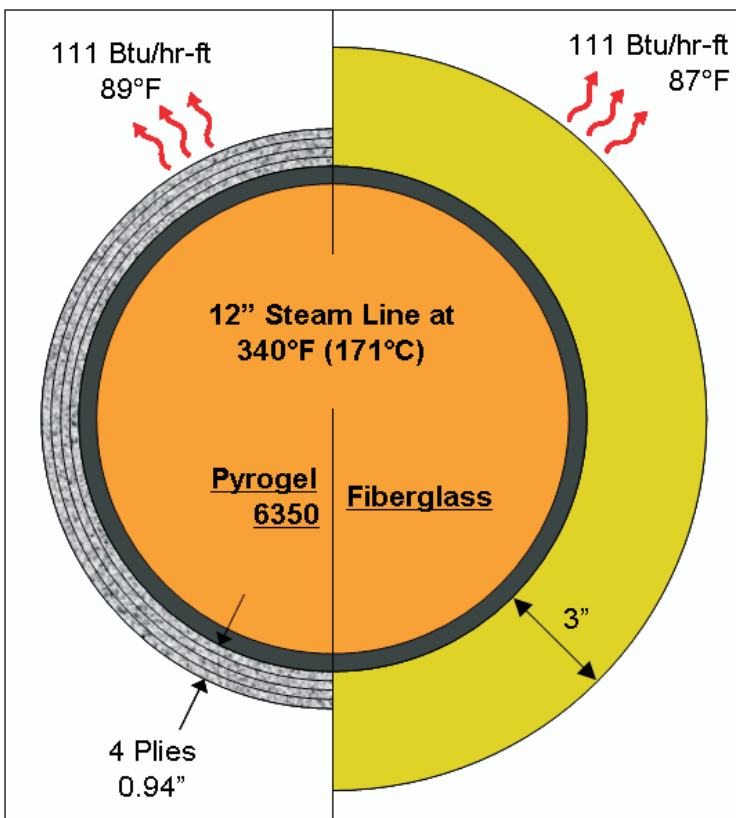
### Aerogel Pipe Insulation Reduces Thermal Loss in Radial Geometries

Traditional steam pipe insulation systems employ mineral wool, fiberglass, calcium silicate, perlite, or various foams. They are typically applied as rigid clamshells or blocks, then clad with sheet metal to protect from weather and service “wear and tear.” Aerogel-based pipe insulation performs a similar function but, as a flexible blanket material with intrinsic hydrophobicity, is not susceptible to the embrittlement or water logging that deteriorates traditional materials. Aerogel has very low thermal conductivity and recent processing developments allow its economical manufacture in blanket form. The most notable feature of aerogel insulation is that it significantly reduces the amount of material needed to perform the same thermal function.



Aspen Aerogels manufactures inexpensive aerogel-based insulation in blanket form.

*Image courtesy of Aspen Aerogels.*



Less than 1" of aerogel-based insulation is equivalent to 3" of fiberglass. The aerogel-based insulation also requires 20% less cladding and binding.

*Image courtesy of Aspen Aerogels.*

Aerogels can also be doped to provide durable water repellancy, mitigating one of the primary modes by which insulation degrades and energy is subsequently lost. Keeping moisture out of the insulation system also helps protect pipelines from corrosion. Aerogel, on a weight basis, is more expensive to produce, but much less material is required, so the improved properties help offset the difference in cost.

In this R&D effort, insulation designs and installation protocols were developed to facilitate the widespread adoption of aerogel-based pipe insulation (ABPI) in industries that heavily rely on steam distribution systems. R&D focused on assemblies that are not currently cost-effective to insulate, such as large diameter, complex, and/or high-temperature pipe systems. This work culminated in the development and commercial deployment of Aspen Aerogels's Pyrogel XT® flexible aerogel blanket insulation, which has been met by high demand from end users.

### Benefits for Our Industry and Our Nation

Aerogel-based insulation reduces energy losses in industrial steam distribution systems applications. The value proposition for aerogel-based insulation is that it delivers better thermal performance, improved durability, and faster installation times than the incumbent insulation materials used in industrial steam applications. The aerogel's low conductivity allows for thinner insulation requirements, which help keep cost competitive with conventional insulations products. Other benefits include long-term water resistance and the ability to wick water away from the pipes, reducing pipe corrosion.

## Applications in Our Nation's Industry

The insulation systems developed in this project can be applied to steam systems across most industrial sectors.

## Project Description

The goal of the project is to improve the high-temperature performance, durability, and life expectancy of aerogel insulation materials.

## Barriers

Major barriers include the following:

- High manufacturing costs for aerogels
- Industry requirements for insulation survivability temperature of 1200°F
- High dust production during aerogel installations
- Lack of a complete OEM aerogel insulation system, including sheathing and barrier materials, fastening systems, and a defined installation method

## Pathways

The program first thoroughly defined the insulation product requirements for the targeted industrial steam line market. Then it validated which of the requirements were already met by the existing aerogel insulation material previously developed by Aspen Aerogels. Subsequent work focused on improving the aerogel blanket insulation to withstand high-temperature environments and meet thermal performance requirements.

In parallel, throughput of Pyrogel was increased significantly in the manufacturing environment through manufacturing process improvements. Aspen Aerogels and Sproule Manufacturing developed complimentary aerogel products to offer a complete pipe insulation system, including aerogel coverings for pipe elbows, pipe flanges, and small bore pipes which speed installation and ensure proper fit. Finally, the product was demonstrated and documented at five facilities: three industrial sites and two government installations. These demonstrations validated Pyrogel XT's superior performance and cost savings relative to incumbent insulation materials.

## Milestones

- Complimentary product applications review (Completed)
- Complimentary product development (Completed)
- Complete five distinct in-service demonstrations to validate performance (Completed)
- Complete industry acceptance activities (Completed)
- Carry out production process optimization (Completed)
- Scale-up technology (Completed)

## Commercialization

At the start of the effort, the Aspen team developed a two-pronged commercialization plan to saturate the addressable pipe insulation market. The first component of this plan was to reduce material costs and the second one was to increase ABPI performance and durability at high temperatures.

A complete line of Pyrogel XT products is now available to match most standard pipe sizes. The network of distribution and installation partners for aerogel-based pipe insulation has grown significantly during the project and to date there are more than 40 distribution partners throughout the world.

## Project Partners

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