Polyurethane Foam vs Mineral Wool vs Cellular Glass Pipe Insulation

Technical comparison for hot water, steam, chilled water, buried thermal lines and industrial piping insulation.

Polyurethane foam
Low thermal conductivity; common in factory-made pre-insulated pipe for district heating. EN 253-type systems are associated with directly buried hot water networks up to 120°C continuous and 140°C peak in standard references.

Mineral wool
Non-combustible pipe insulation with strong high-temperature capability. Typical industrial pipe products are used on steam, boiler, power and process lines up to about 650°C.

Cellular glass
Closed-cell inorganic insulation with excellent moisture resistance, non-combustibility and wide service temperature range; often used in chilled water, cryogenic, buried and severe industrial service.

Main Comparison Table

Material	Useful Technical Data	Main Strength	Main Limitation	Common Application - Specific Use Scenarios
Polyurethane foam (PU / PUR insulated pipe)	• Common in EN 253-type pre-insulated steel pipe systems. • Typical assembly: steel service pipe + rigid PU foam + PE/HDPE casing. • Product references often list PUR foam thermal conductivity around λ50 = 0.026-0.027 W/(m·K). • EN 253 references: hot water service up to 120°C continuous and 140°C occasional peak for applicable systems.	Low heat loss in a compact insulation thickness; factory-made pipe-in-pipe assembly; good for long direct-buried thermal networks where the jacket and joints remain sealed.	Limited high-temperature range compared with mineral wool; field joints and jacket damage can allow water ingress; exposed foam requires fire-safety control.	• District heating supply and return mains under roads and utility corridors. • Direct-buried hot water lines where long continuous pipe runs need controlled insulation thickness. • Chilled water networks where temperature gain and condensation risk must be reduced. • Cold-region buried utility lines where stable pipe temperature is needed. Not normally the first choice for continuous steam service.
Mineral wool (stone wool / pipe section)	• Industrial pipe insulation products are commonly listed for service up to about 1200°F / 650°C. • Many products are non-combustible under standards such as ISO 1182, ASTM E136 or similar product-specific tests. • Supplied as pipe sections, wired mats, boards or blankets, often requiring external jacketing.	Excellent high-temperature and fire-resistance performance; suitable near hot surfaces, steam lines and plant areas where non-combustibility matters.	Needs weather protection and vapor/moisture barrier in exposed or cold service; wet insulation can lose performance; field workmanship strongly affects finish and durability.	• Steam mains, boiler outlet lines, condensate return and high-temperature process piping. • Above-ground pipe racks in refineries, power plants and chemical plants. • Areas near valves, flanges or equipment where insulation may need future removal. • Fire-sensitive building or plant zones where non-combustible insulation is preferred. Requires suitable metal jacket, vapor retarder or weather barrier when moisture is a concern.
Cellular glass (closed-cell glass insulation)	• Inorganic closed-cell glass structure; impermeable to liquid water and water vapor in many product references. • FOAMGLAS references list service temperature range around -265°C to 430°C / -450°F to +900°F depending on product and source. • Common thermal conductivity references are often around 0.038-0.042 W/(m·K) at low/ambient test temperature, product dependent.	Very strong moisture resistance, non-combustibility, dimensional stability and compressive strength; useful where wet insulation failure is a major risk.	Higher material and installation cost; rigid and brittle compared with flexible insulation; joints and vapor sealing require careful fitting and skilled installation.	• Chilled water and low-temperature pipelines where vapor drive is severe. • Cryogenic or cold-service pipe sections in LNG, chemical and industrial plants. • Buried or below-grade piping where groundwater exposure or long-term moisture risk is high. • Hot oil, hydrocarbons, tank bases and support areas needing high compressive strength and non-combustible insulation. Often selected when moisture resistance is more important than lowest initial cost.

Use these values as reference ranges, not universal guarantees. Thermal conductivity, temperature limits and fire classification vary by manufacturer, density, facing/jacket, system design and test method.

Application-Focused Selection Notes

Service Condition	Better Material Direction	Detailed Technical Reason
Direct-buried district heating hot water lines	Polyurethane foam pre-insulated steel pipe	The factory-made pipe-in-pipe structure combines steel service pipe, PU foam and HDPE casing. It is practical for long hot-water routes under roads, plant roads and municipal corridors, provided field joints and casing closure are sealed before burial.
Steam mains, boiler lines and high-temperature process piping	Mineral wool	High-temperature service is usually beyond the practical design range of PU foam systems. Mineral wool pipe insulation is commonly used for steam and process piping because of its high service temperature capability and non-combustible behavior.
Chilled water in humid environments	Cellular glass or polyurethane foam, depending on moisture control	PU foam can reduce temperature gain and condensation risk when vapor sealing is reliable. Cellular glass is stronger where water vapor drive, underground moisture or repeated wetting risk is high because its closed-cell glass structure resists moisture uptake.
Underground or below-grade pipe sections with high groundwater risk	Cellular glass or carefully jointed PU pre-insulated pipe	The main decision is moisture risk. Cellular glass is strong where insulation must remain dimensionally stable and dry in wet conditions. PU systems require intact HDPE casing, sealed field joints and careful repair of jacket damage before burial.
Exposed plant pipe racks with future inspection access	Mineral wool with metal jacket	Pipe racks often include valves, flanges and supports that may need future access. Mineral wool sections and metal jacketing are easier to open and repair than a bonded buried pre-insulated system.
Fire-sensitive or hot-work areas	Mineral wool or cellular glass	Both materials offer non-combustible options. PU foam may require additional protection or may be avoided where exposed insulation could contact ignition sources during welding, grinding or maintenance work.

Practical Reading of the Comparison

Choose polyurethane foam
when low heat loss, compact insulation, factory-made pipe assembly and direct burial are the main requirements. Strongest in district heating and long buried hot water or chilled water runs.

Choose mineral wool
when high temperature, steam service, non-combustibility and easy access for exposed piping are more important than compact insulation thickness.

Choose cellular glass
when moisture resistance, vapor impermeability, compressive strength and long-term stability in wet or cold service are the main design drivers.

Data References

• EN 253 / standard previews: pre-insulated bonded pipe systems for directly buried hot water networks, commonly referencing 120°C continuous and 140°C peak service for applicable systems.
• Rovanco EN253 reference: PUR foam thermal conductivity listed as λ50 = 0.0260 W/(m·K), operating temperature up to 120°C for product system.
• Johns Manville MinWool-1200 Pipe data: mineral wool pipe insulation for mechanical / power / process piping from 0°F (-18°C) to 1200°F (650°C), with non-combustibility information in product data sheet.
• FOAMGLAS / Owens Corning and insulation industry references: cellular glass insulation with closed-cell structure, moisture resistance, non-combustibility and service temperature references around -265°C to 430°C / -450°F to +900°F depending on product source.