

# Liquid Water Absorption



Up to 98% of insulation system problems are caused by moisture—and moisture usually enters through the jacketing or waterproofing membrane. Even in high temperatures, water can be a major problem.

## PROBLEMS

- *Water's Effects*

- Accelerates heat loss or gain, causing increased energy consumption, boil-off of low-temperature liquids and materials solidification in high-temperature systems.
- Leads to physical deterioration of the insulation resulting in dimensional changes which compromise system integrity.
- In pipelines or other equipment, water can cause corrosion of carbon steel and chloride stress cracking of austenitic stainless steel which can cause unsafe conditions and increased operating costs.

- *Low-Temperature Service*

Most low-temperature system insulations are closed-cell foams in order to minimize moisture intrusion. However, not all closed-cell foams have the same water vapor permeability and can be penetrated via a water vapor gradient that occurs due to a difference in equipment operating temperature and ambient air temperature. Thus, these cellular foams are not vapor barriers.

Wet insulations in low-temperature service have no opportunity to dry out. Moisture migrates to the point of lowest temperature and builds to permanent liquid saturation or ice accumulation.

- *High-Temperature Service*

Insulations used in high temperatures are generally absorptive fibrous or particulate materials:

- Calcium silicate can hold over 400% of its weight in water without dripping (up to 90% moisture is not unusual), and complete saturation can occur in under three hours.
- Mineral wool is another possibility, but it too can be prone to moisture. In fact, moisture absorption on 572°F (300°C) steam lines at a United Kingdom chemical plant led to the production of up to 60 extra tons of steam per hour.

- *Water Repellents*

Silicone treatments can be somewhat effective as water repellents on high temperature insulations, but their performance may be destroyed by service conditions.

With silicone-treated mineral wools, repellent effectiveness may begin to deteriorate at 265°F (129°C) and is completely gone at 380°F (193°C). These treated insulations can become saturated in less than 24 hours of exposure to boiling water or steam. Perlite is available with or without repellents. Without repellents, saturation occurs in less than three hours. With repellents, effectiveness is compromised at conditions as mild as 100°F (38°C) and 97% relative humidity—weight increases up to 40% and thermal conductivity up to 50%.

- *Water Entry*

Water entry can occur with normal precipitation, cleaning, melting/dripping from cold equipment, steam traps, cooling tower mists and deluge testing.

<b>MOISTURE ABSORPTION</b>	
<b>Insulation Material</b>	<b>Absorption % by Vol.</b>
FOAMGLAS® Insulation	0.2
Polyurethane or Polyisocyanurate	1.6
Polystyrene	0.7
Phenolic	10
Fibrous Glass	50-90
Mineral Fiber	nil-90
Calcium Silicate	90
Expanded Perlite	2-90
<small>           _ The only moisture retained is that adhering to surface cells after immersion.            _ Waterproofing agents may be destroyed when exposed to temperatures of 250°F (121°C) or higher         </small>	

- *Drying Out*

Once moisture gets into insulation, it may never completely dry out—even on steam lines at 1000°F (538°C).

In water retention tests using 3" (76mm) of calcium silicate on a 6" (152mm) pipe operating at 500°F (260°C), the outer 1" (25mm) remained saturated and heat loss was 111% higher than with the dry insulation system. Also, the jacket temperature had risen above the 140°F (60°C) personnel safety level.

In another experiment, a 6" (152mm) pipe operating at 450°F (232°C) was insulated with 2" (51mm) of calcium silicate for economic optimization. After 28 days, the outer portion of the insulation was still wet and power consumption was 42% above dry insulation conditions. It would be common to experience some form of precipitation in that time period. Consequently, once moisture gets into insulation, repeated intrusion virtually eliminates the possibility of dry out. However, one system can correct this problem on high-temperature equipment.

## The FOAMGLAS® Cellular Glass Insulation Solution

- *Water Resistance*

Cellular glass insulation consists of a network of non-interconnecting, 100% glass cells exhibiting outstanding resistance to moisture in liquid and vapor forms. When tested via ASTM C 240-85, which requires two hours of immersion, cellular glass has a maximum, combined absorption/absorption value of 0.2%, by volume.

- *Precautions*

While cellular glass provides unequalled thermal effectiveness in the presence of liquid water, precautions must be maintained.

At temperatures cycling around 32°F (0°C), freeze/thaw damage can occur to the insulation from trapped or ponded water. Joints between insulation lags should be sealed with a permanently resilient mastic, such as nonsetting butyl sealant. For system temperatures below -60°F (-51°C), multiple insulation layers are recommended with sealant at the outer-layer joints only.

For ammonia sphere or LPG tank operation in the -67 to 158°F (-55 to +70°C) range, a proprietary two-component, urethane-modified bitumen adhesive can both adhere the insulation to the metal substrate and seal the insulation joints. This compact system eliminates spaces for moisture to enter and eliminates the need for a vapor barrier. (Jacketing, mastics or membranes should always be used to protect outer-surface insulation cells.)

For applications which involve prolonged exposure to very high temperature water or condensing steam (like kiln linings), unprotected cellular glass has a finite service life measured in years. That's still considerably longer than the minutes-long or hours-long lifespan of many other insulations.

For more conventional high-temperature applications, prolonged effectiveness can be assured with an efficient weather barrier. And thanks to the water resistance of cellular glass, strategically placed weep holes may also be uniquely effective in the event of accidental water intrusion.