MicroBooNE Tank Insulation

Introduction

The liquid Argon tank proposed for the MicroBooNE neutrino experiment is a single shell stainless cylinder without vacuum insulation.

The thermal insulation will be provided at the outside of the tank

We plan to use blown-in-place Polyurethane foam insulation.

Properties of Urethane Foam

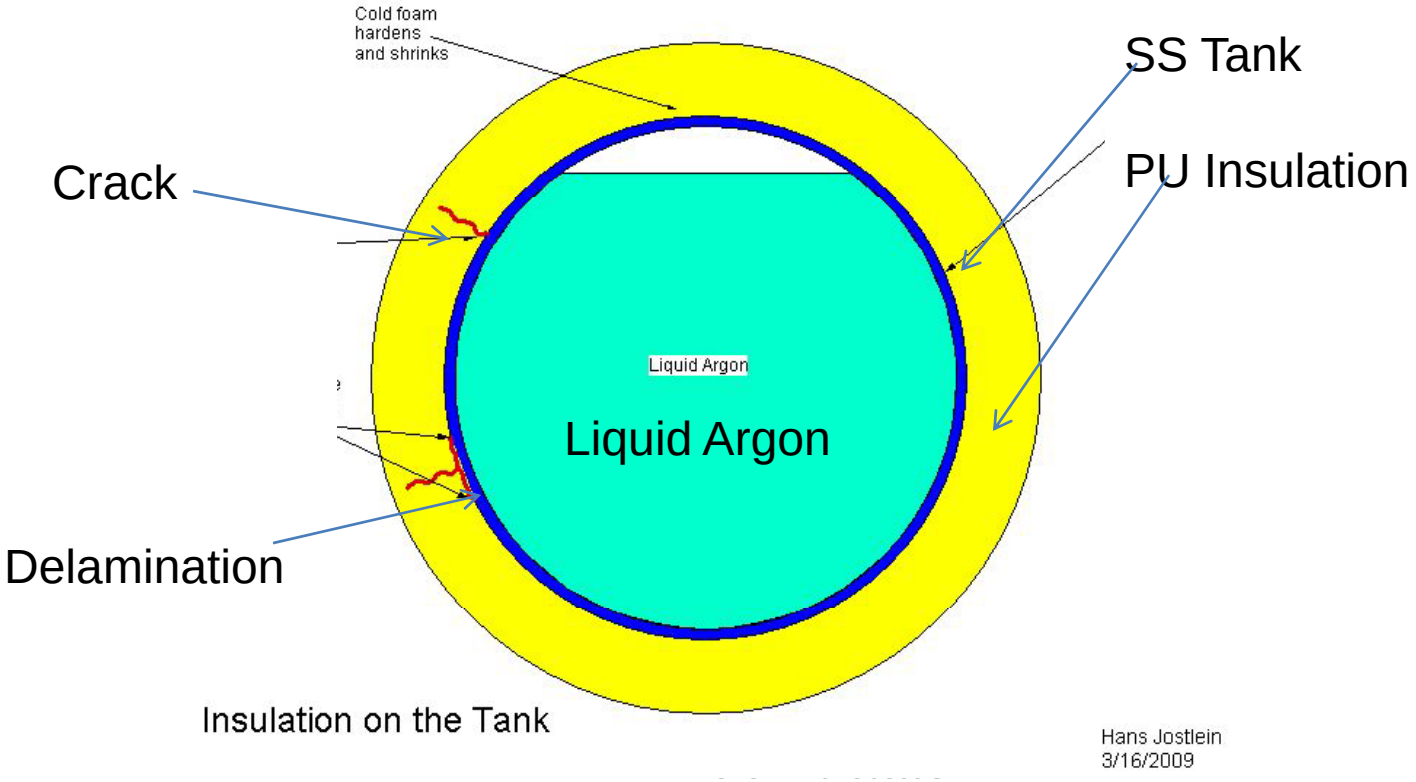
-- good seal against water vapor and air infiltration
-- easily adaptable to complex surfaces
(supports, pipe connections, flanges)
-- uses minimal space
-- widely used commercially
-- fast and inexpensive commercial installation

Concerns,
mostly relating to thermal contraction stresses:

-- will the foam crack on cool-down?

-- will the foam separate from the tank surface in a progressive failure mode?

-- will radial cracks form on the tank surface and propagate radially outward?



The Cracking Mechanism

On Cooldown, foam shrinks by about 0.95 % while steel shrinks only 0.3 %.
The foam is bonded to the steel (or looped around it) and ends up under tension.

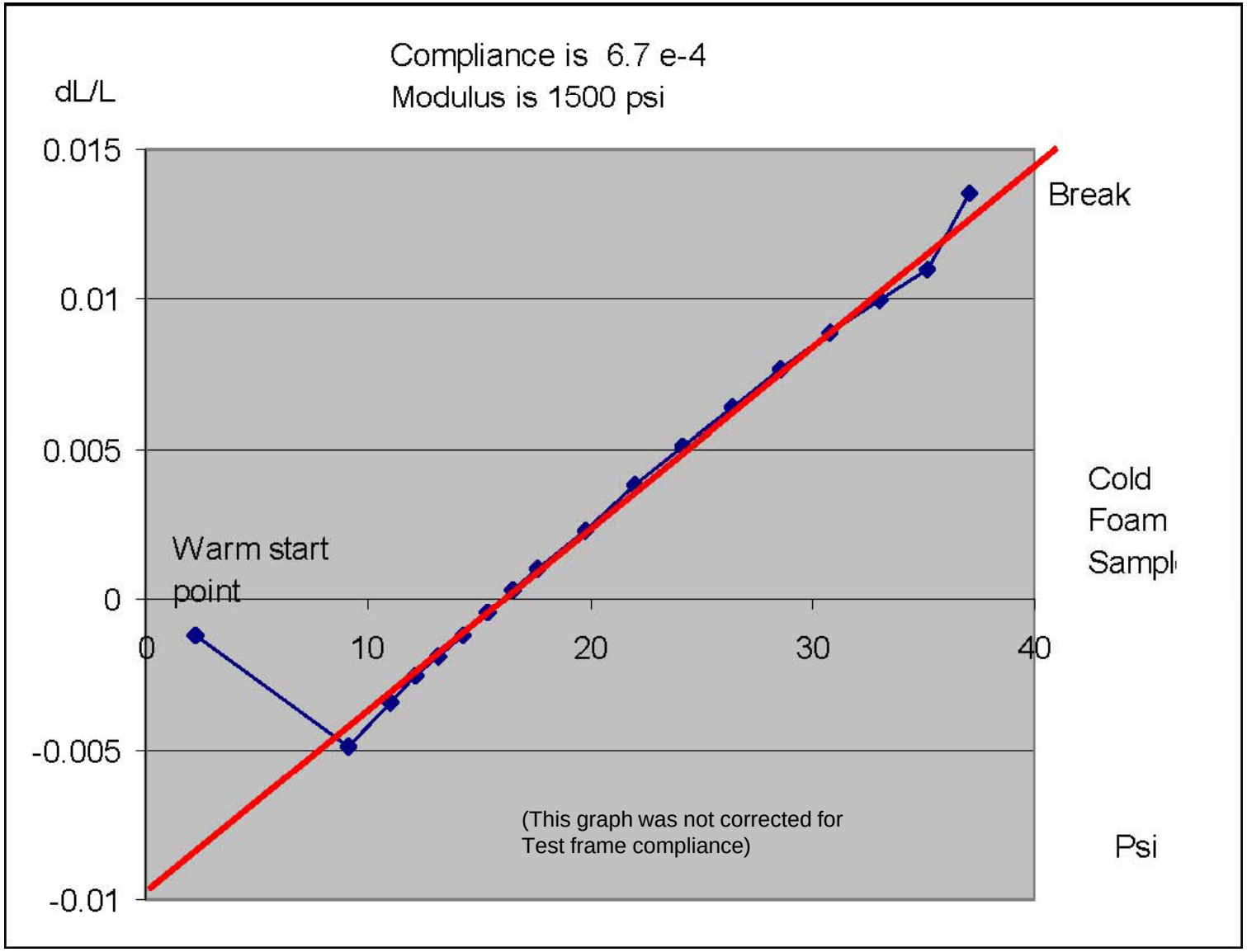
We have made two types of measurement:

a. We made many samples of foam on SS, and cold shocked them multiple times -- no cracking or delamination was observed.

b. To measure a safety factor against cracking, we have measured thermal contraction, cold foam modulus, and tensile strength, on several foam samples. We find a safety factor of about 2 against cracking.

Cold Test Stand

Some of the Samples:


Compliance is 6.7 e-4
Modulus is 1500 psi
dL/L
0.015
0.01
0.005
0
-0.005
-0.01
0
10
20
30
40
Break
Warm start point
Cold Foam Sampl
(This graph was not corrected for Test frame compliance)
Psi

Additional Safeguards against Cracking

We intend to install three layers of fiberglass mesh:

-- one in direct contact with the SS vessel

-- a second one after the first layer of foam (a 1.5” lift) is installed.

-- a third layer will be installed on the surface before the mastic is applied (as per Mfr recommendations)

Foam Flammability Results from the Fermilab Fire Protection Engineer, Dr. James Priest:

The foam works well .
In a vertical position it would not support combustion when the flame was removed in three 20 sec intervals and then in a continuous burn.
It also does not drip or produce flaming drips. I
n the horizontal l it also does not burn when a flame is removesd.
If a source was in contact it will burn and you can see producing a flame several cm from the surface which could ignite other material.
It does produce a lot of thick smoke.
The cotton pad collecting the smoke produced a 4.1 PH.
We need to test with the coating to make sure the coating in not worse then leaving the foam exposed.
I will write a formal report when we test the coating.

Note:

Dr. Priest is charged by the Fermilab Director to recommend approval or disapproval for installations, based on their flammability.

Other Considerations are:

-- we need a water vapor barrier to use
on the outer surface to prevent ice formation inside the foam
-- fire protection
-- protection from physical damage.

These are shared with industrial insulated tanks and have well-known solutions:

The Childers CP-35 is a water soluble mastic with very low permeability and a good fire rating

The Polyurethane foam has been tested by the Fermilab fire protection engineer and found acceptable. It didn't burn:

Results from Coating Tests performed

by the Fermilab Fire Protection Engineer, Dr. James Priest :

"I tested the attached vapor product for Terry Tope on their foam. It worked very well. "

"I tested the PU Foam with the Foster Vapor Mastic.
It did very well.
I have a CD on my test for you.
I did notice on particular oddity. I could get the Foster mastic to burn on the edge sometimes but not to propagate and would self extinguish. It seemed to be more a film burning on the surface and not the mastic itself and it only happened on the edge in a few places."

Commercial Installation

The installation job will be bid.
So far we have worked with one commercial installer:

Innovative Insulation Solutions,
Elk Grove Village, Illinois
Foam@gotfoaminsulation.com

Foam Installation