



CUSTOMER BULLETIN 04-10
A COMPARISON OF ISO-C1[®] and HT-300
POLYISOCYANURATE INSULATION

PURPOSE

This Customer Bulletin is part of a series of white papers aimed at providing our clients, engineers, contractors, fabricators, and friends with objective information on competitive products. Marketing literature on the internet and in printed media address the physical and performance characteristics of competing polyisocyanurate rigid foam insulations fabricated from bunstock. As is often the case, some literature can be misleading and/or in some cases there may not be sufficient information to credibly compare products. This Customer Bulletin provides factual, clarifying information which should allow for an objective comparison of Dyplast's ISO-C1[®] with HiTherm's HT-300 (each 2 lb/ft³ density).

TO-THE-POINT SUMMARY COMPARISON

Dyplast ISO-C1 (nominal 2 lb/ft ³)	HiTherm HT-300 (nominal 2 lb/ft ³)
Manufactured in U.S.	Manufactured outside the U.S.
Blowing agent: pentane (various isomers) Blowing agent GWP: ~10 Blowing agent ODP: 0.0	Blowing agent: HCFC (banned in U.S. ¹) Blowing agent GWP: ~700 Blowing agent ODP: 0.11
Physical Properties independently verified and audited by certified independent laboratories	Physical Properties apparently <u>not</u> independently verified ²
<u>Flame spread</u> : 25 up to 4 in. (<u>FM rating</u>)	<u>Flame spread</u> : 25 ≤ 2.5 in.
<u>Smoke developed</u> : 130 up to 4 in. (FM rating)	<u>Smoke developed</u> : 50 ³ ≤ 2.5 in.
<u>K-factor</u> : 0.176 aged	<u>K-factor</u> : 0.165 aged
<u>Water vapor permeability</u> : 2.33 perm-in	<u>Water vapor permeability</u> : 4.0 perm-in

¹ Manufacture of polyiso bunstock using HCFCs is banned in the United States and other developed countries as of January 1, 2005

² Could not be verified by literature/internet search

³ Not verifiable since no independent lab testing was declared, yet not inconceivable given use of the banned blowing agent HCFC



Dimensional stability (length) ⁴ : <1.0%	Dimensional stability (length) ⁴ : 2.3%
Dimensional stability (volume) ⁴ : <2.0%	Dimensional stability (volume) ⁴ : 3.8%
Closed cell content: >95%	Closed cell content: >90%
Compressive strength (parallel to rise): 26 lb/in ²	Compressive strength (parallel to rise): 30 lb/in ²
Fabricated in U.S.	Fabricated in U.S.

POLYISOCYANURATE BACKGROUND

Polyisocyanurate (polyiso or “PIR”) rigid foam is often misidentified as a polyurethane foam (PUR) when, in fact, it is based on a significant modification to standard polyurethane chemistry. Polyiso foams have a higher ratio of polyisocyanates to polyols (a higher “index”) than do polyurethane foams. The nature of this high-index foam imparts many advantageous properties to the foam including dimensional stability, thermal stability, solvent resistance, and superior flame resistance. Thus PIR has become the insulation of choice for insulation in applications under 300F, with performance far exceeding extruded polystyrene, expanded polystyrene, fiberglass, cellular glass, mineral wools, and so forth.

Yet worldwide efforts to mitigate indisputable global ozone layer damage have motivated the industry to move toward environmentally friendly chemicals in the production of PIR - - even at the expense of slight reduction in performance.

ENVIRONMENTAL

Ozone Depletion

Ground-level ozone of course contributes to SMOG, which in turn can have adverse effects on respiratory ailments, as well as reduction in visibility and so forth. Yet a decrease in ozone concentrations in the upper atmosphere allows damaging ultraviolet radiation (UV) to penetrate the atmosphere, and can cause cancer in humans and/or cell mutations in plants and animals. It is this latter problem that motivated major movements by countries around the world (including the international treaty referred to as the Montreal Protocol) to strive to reduce Ozone Depletion Potential (ODP). One element of their efforts has been to require a logically beneficial transition away from chemicals that contribute to ozone depletion high in the atmosphere - - namely CFCs and HCFCs.

Yet as is often the case, to mitigate undue economic hardship on “developing” countries the Treaty allows countries such as Mexico, the Caribbean, certain Central/South American countries, and others to continue use of certain HCFCs until 2040! (after which time it will be a violation). The problem for the United States arises from a loophole in enforcement that allows, for instance, a manufacturer of an HCFC-containing insulation product in a developing country to legally ship it into a developing country (e.g. the U.S.). The ultimate impact on the environment is the same - - ozone-depleting gases are released. Although strict penalties apply

⁴ At 158°F, for 7 days at reported 97% relative humidity for ISO-C1, and 100% humidity for HT-300



to smuggling CFC and HCFC into the U.S. (<http://www.epa.gov/Ozone/enforce/blackmkt.html>), the importation of a product manufactured with the same CFCs/HCFCs is immune to such penalties.

Greenhouse Gases/Global Warming

Although "Global Warming" is still being debated on the fringes of the population, the existence of "Greenhouse Gases" is not. Fortunately, the Montreal Protocol's restrictions on CFCs and HCFCs also result in a significant reduction in greenhouse gases, that in turn reduce the likelihood that the average global temperature will increase.

INDEPENDENT TESTING OF PHYSICAL PROPERTIES

Clients and end-users of insulation products have the right to absolute confidence that the representations of insulation manufacturers/suppliers are accurate. Third party, independent verification of physical properties is only the first step to ensure credible, objective data is published (subsequent audit and re-test is the second). In fact, a single test at an independent lab verifies only that a single batch of product produced a given set of results.

Dyplast not only uses third party independent verification of all ISO-C1 physical properties, but additionally funds an audit process whereby the independent laboratory randomly visits the manufacturing facility to monitor how the product is produced - - verifying that the chemistry and process are consistent with the conditions of the prior tests. In this respect, Dyplast's ISO-C1/2.0 product is both tested and has received FM Approval, is *listed*⁵ at UL, approved by ICC, and is tested and audited by RADCO⁶.

Literature and internet searches for comparable verification of HT-300 physical properties were unsuccessful.

FLAME AND SMOKE

The unfortunate fact is that when manufacturers in developing countries phased out CFC/HCFC pollutants as blowing agents in polyiso bunstock, the flame spread index (FSI) and smoke developed index (SDI) of their products deteriorated. In the past, polyiso bunstock foams manufactured with CFC blowing agents often achieved 25FSI and 50SDI up to 4 inch product thickness. With HCFC blowing agents manufacturers had a difficult time achieving 25/50 at 2 inches. Today, manufacturers in developed countries have generally turned to hydro-carbon blowing agents; and at this stage there is no bunstock manufacturer in any developed country that credibly advertises 25/50 - - at any thickness. Dyplast may be one of the few that continues its aggressive R&D efforts to meet this challenging objective.

⁵ Underwriters Laboratories, the world's largest, not-for-profit product safety testing and certification organization with global name recognition and acceptance. Founded in 1894 in the US, it permits the use of its listing mark (the UL mark) as its stamp of approval on goods and materials after standardized and stringent testing. Thereafter its inspectors regularly visit the producer to audit compliance with its certification requirements.

⁶ RADCO is a nationally recognized testing laboratory, listing and quality control inspection agency headquartered in Long Beach, California, with branch offices across the U.S.



[Note: The 25/50 market is discovering phenolic foam insulation as the insulation-of-choice due to its incredibly high insulating value compared to the alternatives of cellular glass and fiberglass, each of which have additional drawbacks. Dyplast supplies phenolic insulation meeting 25/50.]

THERMAL PERFORMANCE

Correspondingly to the above relationship between flame/smoke and blowing agent chemistry, manufacturers in developed countries have observed a deterioration in thermal resistance (higher K-factors) when using more environmentally-friendly hydrocarbon blowing agents (as compared to now-banned CFCs and HCFCs). The good news is that polyisocyanurate insulation continues to provide the highest thermal performance per cost compared to any commercially available insulation.

Credible verification of HT-300's K-factor could not be found so it is difficult to dispute the aged K-factor of 0.165 listed on HT-300 datasheets. Dyplast's ISO-C1 aged K-factor is higher, yet compares favorably at 0.176, which is the best of all the current pentane blown foams on the market. Dyplast's K-factor has been confirmed by independent tests and audits.

WATER VAPOR PERMEABILITY

Water vapor permeability is one of the most important physical properties, particularly for pipe insulation. Insulation systems inherently have a "vapor drive" where the second law of thermodynamics dictates that water-vapor/moisture flows from the wetter/warmer side to dryer/cooler side. In a chilled water or cryogenic application, for example, the water vapor will collect and/or freeze on the pipe, valves, and equipment, potentially reducing operability of moving components and dramatically corrupting the thermal performance of the insulation system. Indeed a "low-perm" vapor retarder is often wrapped over the insulation material as part of an *insulation system* to improve the overall permeability of the system. Yet vapor retarders have low resistance to punctures and tears, and can often fail in situations where mechanical abuse is a threat (e.g. stepping on the insulated pipe). The bottom line! When there is a choice between comparable insulations, the best choice is the insulation with the lower water vapor permeability. Dyplast's ISO-C1 has a water vapor permeability of 2.33, while HT-300's is 72% higher at 4.0.

DIMENSIONAL STABILITY

Dimensional stability is a measurement of a material's change in dimensions—length, width, thickness — over time in response to various environmental exposure conditions such as temperature and humidity. Sometimes manufacturers provide a "volume" measurement as an indication of the 3-dimensional changes. Dimensional stability varies with the type of material and the specific chemical/physical makeup. Since the ASTM D-2126 test is a material test only, it is not intended to address that material's performance as part of an overall insulation system.

All insulations have some dimensional instability; insulation system designs and quality installation can mitigate or eliminate its effect on thermal performance. Yet very poor dimensional stability can cause swelling, expansion, shrinkage and buckling of a system's insulation. These actions, in turn, can eventually lead to thermal bridges, vapor



retarder/jacketing breaches, and unpredictable insulation performance. Another bottom line! - - - when there is a choice between comparable insulations, the best choice is the insulation with the best (i.e. lower) dimensional stability.

The following are the dimensional stability measurements of ISO-C1 versus HT-300, measured per ASTM D-2126:

Dimensional Stability, % Change	ISO-C1	HT-300⁷
-40° F (-40° C), 7 Days		
Length	<0.1%	Not available
Volume	<0.1%	Not available
-20° F (-30° C), 7 Days		
Length	Can be inferred by interpolation	0.1%
Volume	Can be inferred by interpolation	1.3%
158° F (70° C), 97-100% R.H., 7 Days		
Length	<1.0%	2.3%
Volume	<2.0%	3.8%
212° F (100° C), 7 Days		
Length	<0.1%	1.0%
Volume	<1.0%	2.3%

WATER ABSORPTION

Water absorption is a very important physical property since water materially degrades the thermal efficiency of insulation. Dyplast has excellent water absorption characteristics of 0.24% as measured by ASTM C-272. For comparison, this is well below the 0.3%⁸ for extruded polystyrene, and 2.0%⁹ for ~2 lb/ft³ density expanded polystyrene. It is not possible to compare ISO-C1 with HT-300 since the water absorption of HT-300 is measured using ASTM D-2842, which determines water absorption by measuring the change in buoyant force (lbs/ft²) resulting from immersion under a 2 inch head of water for 96 hours.

⁷ Technical Datasheet for HT-300 (<http://www.pirsupply.com/ht-300tech-data.pdf>)

⁸ Extruded Polystyrene Foam Insulation data (<http://www.xpsa.com/tech/standards.html>)

⁹ EPS Molders Association data (http://www.epsmolders.org/PDF_FILES/C578%20Chart.pdf)