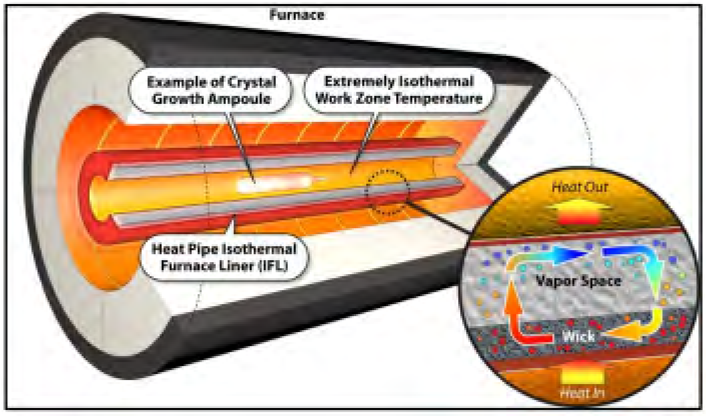
Datasheet

Isothermal Furnace Liner

What is an Isothermal Furnace Liner

Boyd's Isothermal Furnace Liner (IFL) is an annular heat pipe. In its simplest form, the heat pipe is a sealed tube containing a wicking material, and a small amount of working fluid. The wicking material is placed against the inner wall of the tube and serves to transport the condensed vapor from the location where heat is extracted to the location where heat is applied (Figure 1).



After the heat pipe is evacuated of all noncondensable gases, it is charged with a small amount of liquid. The internal pressure of the heat pipe is determined by the vapor pressure of the working fluid at the operating temperature. The liquid evaporates at the location where heat is applied, and condenses in thin films at the location where heat is extracted. Under these conditions, evaporation and condensation occur at about the same temperature.

How an IFL Operates

The IFL achieves an isothermal wall temperature by the continuous evaporation and condensation of the working fluid. The internal heat transfer coefficient of the wick and wall is 6 kW/m2 ·°C. Radiation dominates heat transfer between the liner walls and anything inserted into the cavity. At 800°C, the corresponding radiation coefficient is only 280 W/m2 ·°C, which is 20 times lower than the internal liner coefficient. As a result, the furnace liner is very effective in isothermalizing its wall temperature, and providing an isothermal environment. A probe may experience the same uniformity, but depends on the heat transfer paths between the probe and the surrounding walls, and between the probe and the outside environment.

Advantages of Using IFLs

IFLs are used for process tubes and laboratory furnaces, and provide better temperature uniformity than is possible with any conventional control technique. A flat temperature profile is inherent to the liner. In most applications, temperature uniformity is within 0.1°C over the liner length. When a single uniform temperature zone is required, the IFL can provide this zone with a single heater and controller. Temperature adjustment is a simple, one-step process; frequent profile measurements are not necessary. Energy can be saved, and productivity increased because usable reaction zone length in a given furnace becomes equal to or larger than the active heater length.

Two or more IFLs may be used in a series to create multiple individually-controlled zones for special effects such as step changes in temperature profile.

Standard and Custom IFLs Are Available

Boyd's standard IFLs (Figure 2), for operation to 1600°C, are available in size range to fit conventional furnace bores for horizontal or vertical applications. Custom IFLs (Figure 3) can be fabricated for sub-ambient and cryogenic operation. The size and geometry of the IFL can be customized to meet specific requirements. Refer to the specifications for standard IFLs, and the illustration of custom IFLs.

Figure 3 – Options for Custom IFLs

Options:

1. Flanged Ends
2. Extended Inner Pipe
3. ILF with Support Rods
4. IFL with Thermocouple Wells
(External, Internal, or Within IFL Wall)
5. Vacuum Retort
6. Hemispherical Dome End
7. Small Diameter Cavity
8. Calibration Wells

Specifications

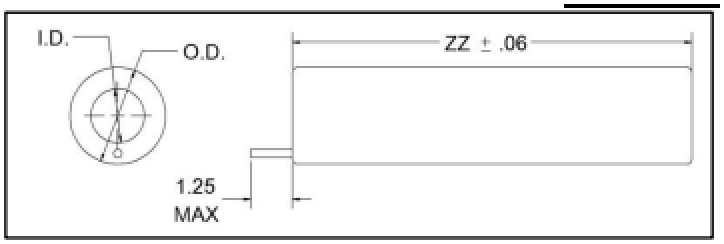
Standard furnace liners may be specified by using the following designations:

F16377- IFL-XX-YY-ZZ

Operating Range (°C)			
XX	Operating Fluid	Range Min.	Range Max.
2	Water	20	300
6	Cesium	300	600
10	Potassium	400	1000
11	Sodium	500	1100
16	Lithium	900	1600

Nominal Diameter ± 0.06 in. 1.5 mm				
YY	I.D. (in)	I.D. (mm)	O.D. (in)	O.D. (mm)
14	1.38	35	2.38	61
16	1.61	41	2.88	73
20	2.06	52	3.50	86
25	2.46	62	4.00	102
30	3.07	78	4.50	114
35	3.55	90	5.00	127
*†40	4.02	102	5.56	141
*†50	5.04	128	6.64	169

Nominal Length ‡		
ZZ	L (in)	L (mm)
6	6.0	152
12	12.0	305
18	18.0	457
21	24.0	610
36	36.0	914
42	42.0	1067



* Potassium IFL-10 restricted to 950°C
† Sodium IFL-11 restricted to 1000°C
‡ For IFL-10 and -11 allow 0.13 (3.3 mm) clearance for each 6.0 in. (152 mm) of length for thermal expansion.

Features, Benefits and Critical Application Need

Features and Benefits	Critical Application Need
Simplified Temperature Control	Thermocouple Calibration
Rapid Temperature Recovery	Black Body Radiators
Increased Productivity	Crystal Growing and Vapor Deposition
Energy Savings	Diffusion and Annealing
Sub-Ambient and Cryogenic Options	Chemical Reaction
-	Vapor Pressure Measurement