Rapid Infrared Preheating of Extrusion Die

M-Plus Project Between

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Current Die Heating Heating Technology

Issues:

• Aluminum extrusion dies and die tooling sizes range from 11.875" X 1", to 24" X 11“ (thickness/diameter).

•In order to have theses dies heated to the extrusion temperature, 820 F, these dies have to be soaked in convection type furnaces for an hour per inch of thickness.

•This means that dies have to be heated 24 hours a day in conventional convection furnaces.

•Real time changes in die tooling are not possible, a predetermined extrusion schedule must be developed to allow for the proper heating time of the tooling.

•Variations in the extrusion schedule can cause large down time of the presses if the appropriate tooling is not preheated to the proper temperatures.

Rapid IR Heating Technology May Enable Heating Dies to Temperature in Less Than 30 Minutes

Benefits:

•Real time changes in extrusion dies without maintaining large numbers of dies at the extrusion temperature.

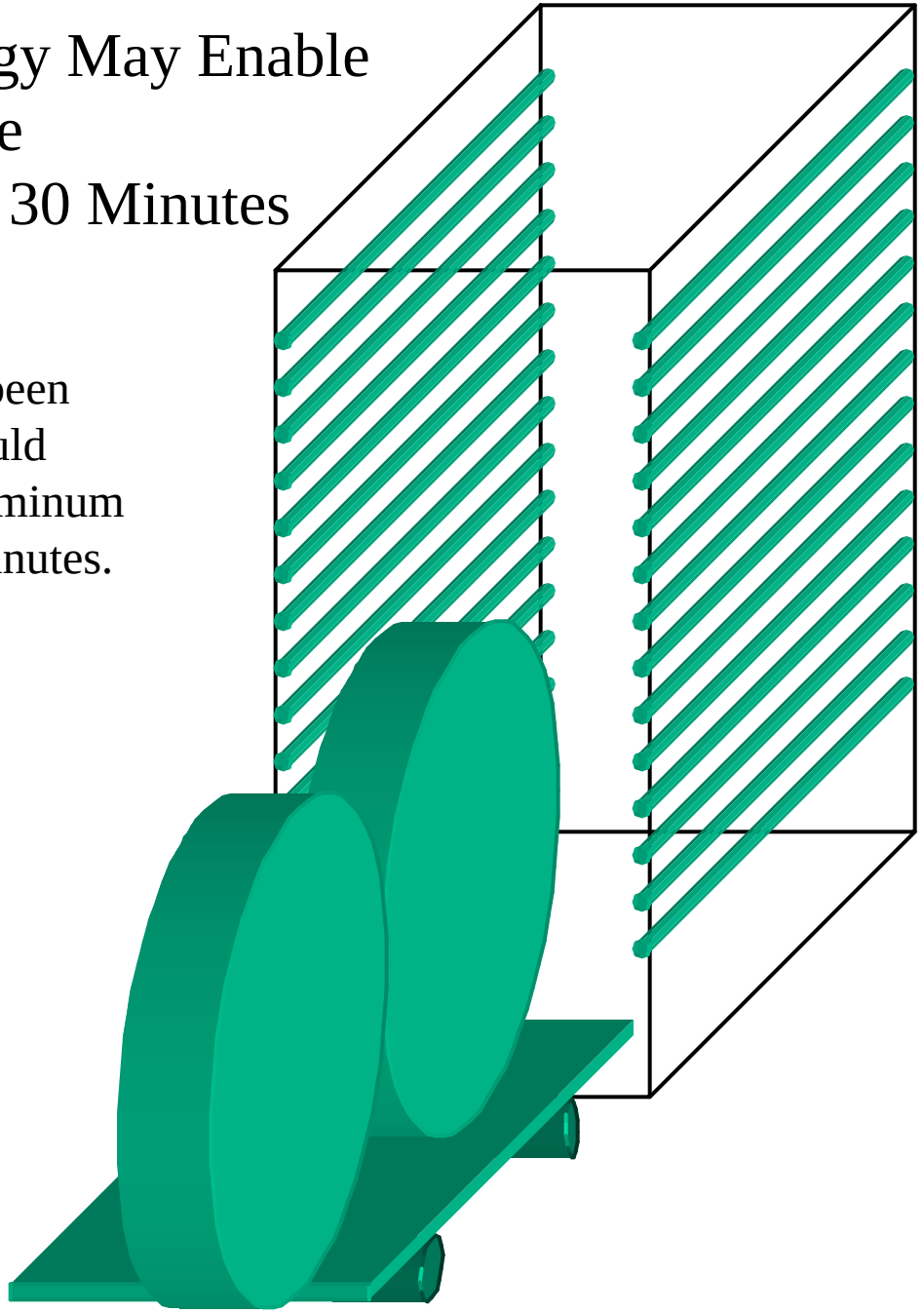
•Energy savings through: 1) reduction in die heating time and 2) reduction in extrusion press downtime.

•Improved product dimensional control through consistent preheating of dies.

• Potentially extension of die life

Rapid IR Heating Technology May Enable Heating Entire Die Stacks in Less Than 30 Minutes

A potential Prototype System has been Preliminarily Developed which could Heat an entire Die Stack for an aluminum extrusion facility in less than 30 minutes.



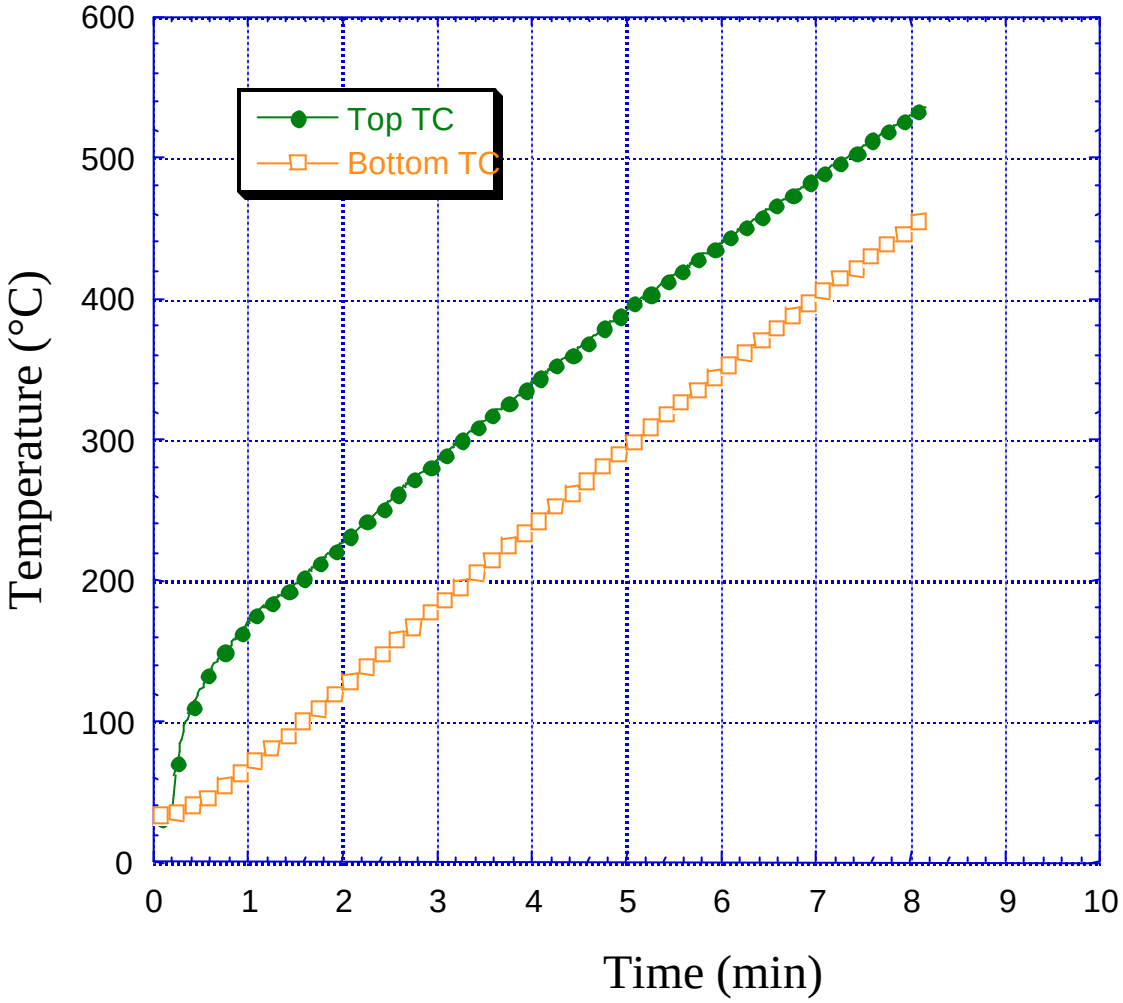
An ***88kW*** 24 inch by 24 inch Flat Bed Infrared Furnace was Utilized For Experimental Work at ORNL

Experimentation:

Two separate dies provided by Alcoa were heating in an 88kW single sided IR heating unit at ORNL.

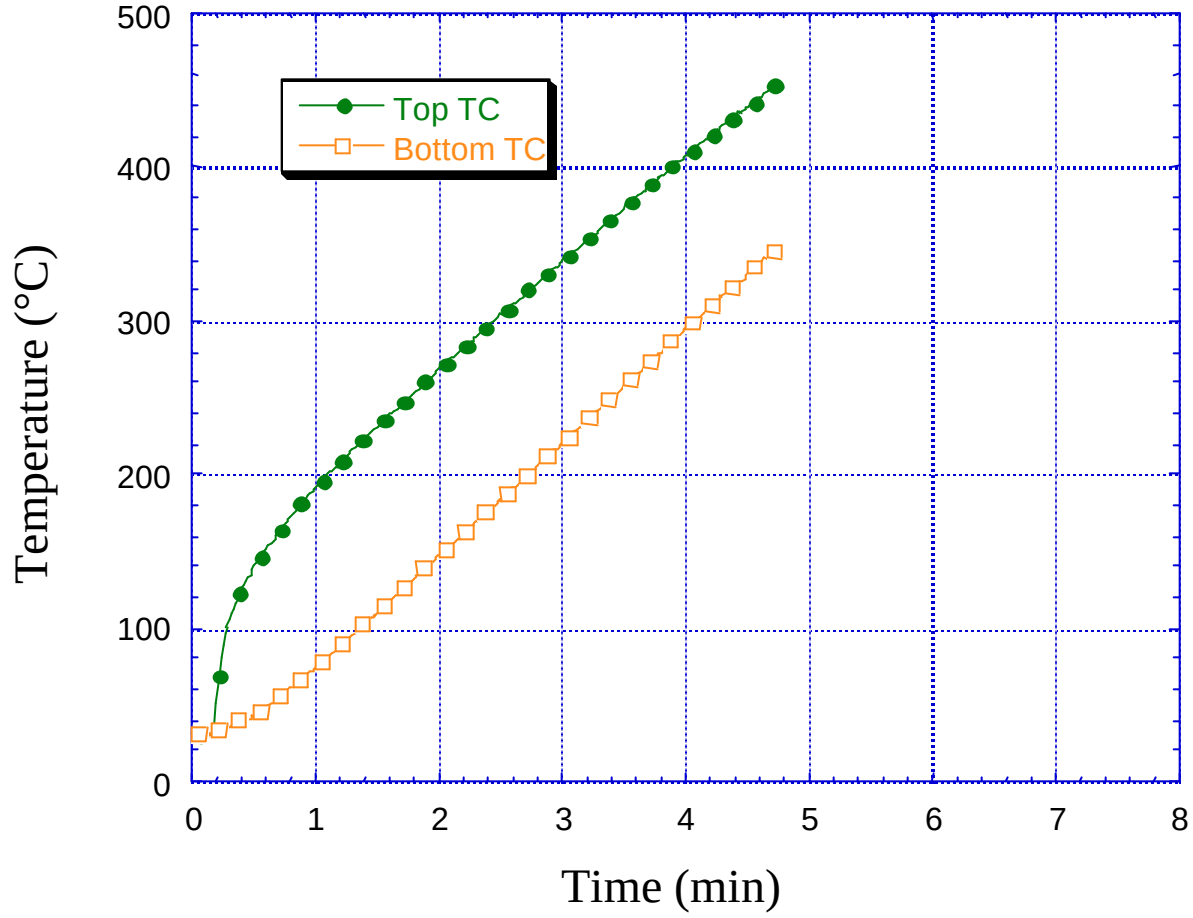
Die Material H-13	-1 inch thick by 18 inches in diameter -2 inch thick by 18 inches in diameter
IR System	- 88 kW single sided IR drop bottom batch furnace - three power levels utilized, 70, 80, 90%

IR Heating Able to Preheat 1” by 12” Die to Operating Temperature in 8 Minutes



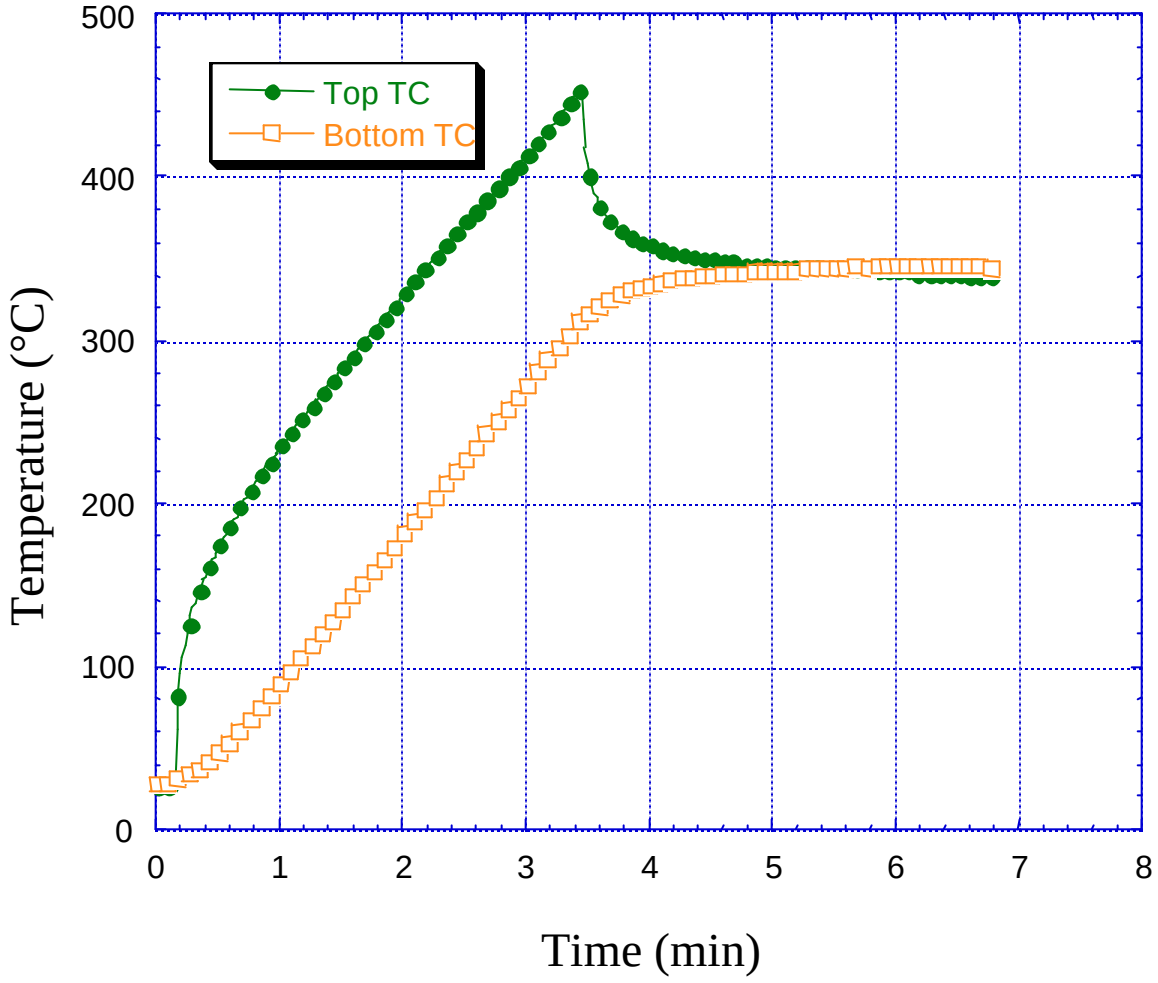
One sided heating at 70% power, front and back side thermal couples.

IR Heating Able to Preheat 1” by 12” Die to Operating Temperature in 5 Minutes



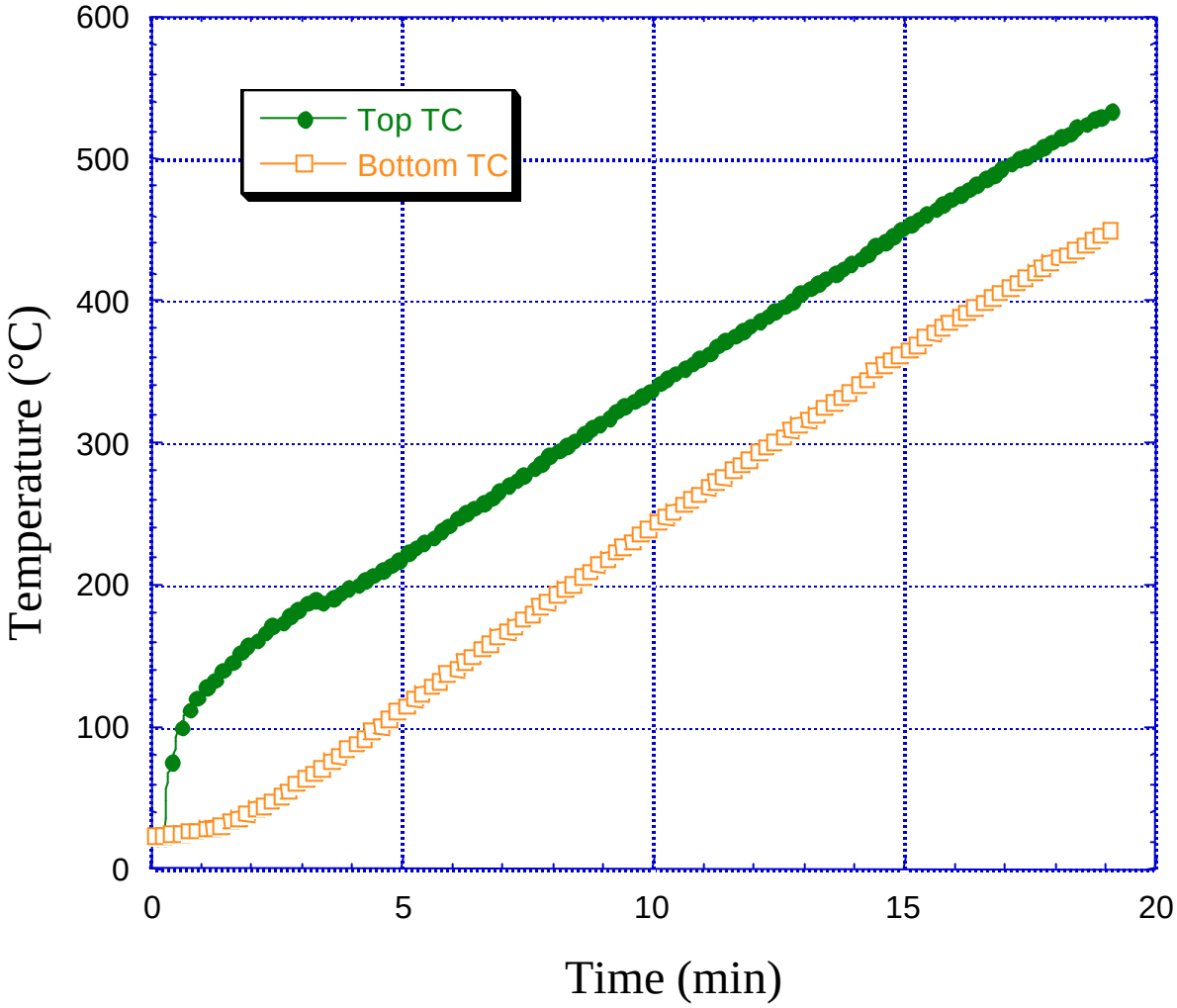
One sided heating at 80% power, front and back side thermal couples

IR Heating Able to Preheat 1” by 12” Die to Operating Temperature in 3.5 Minutes

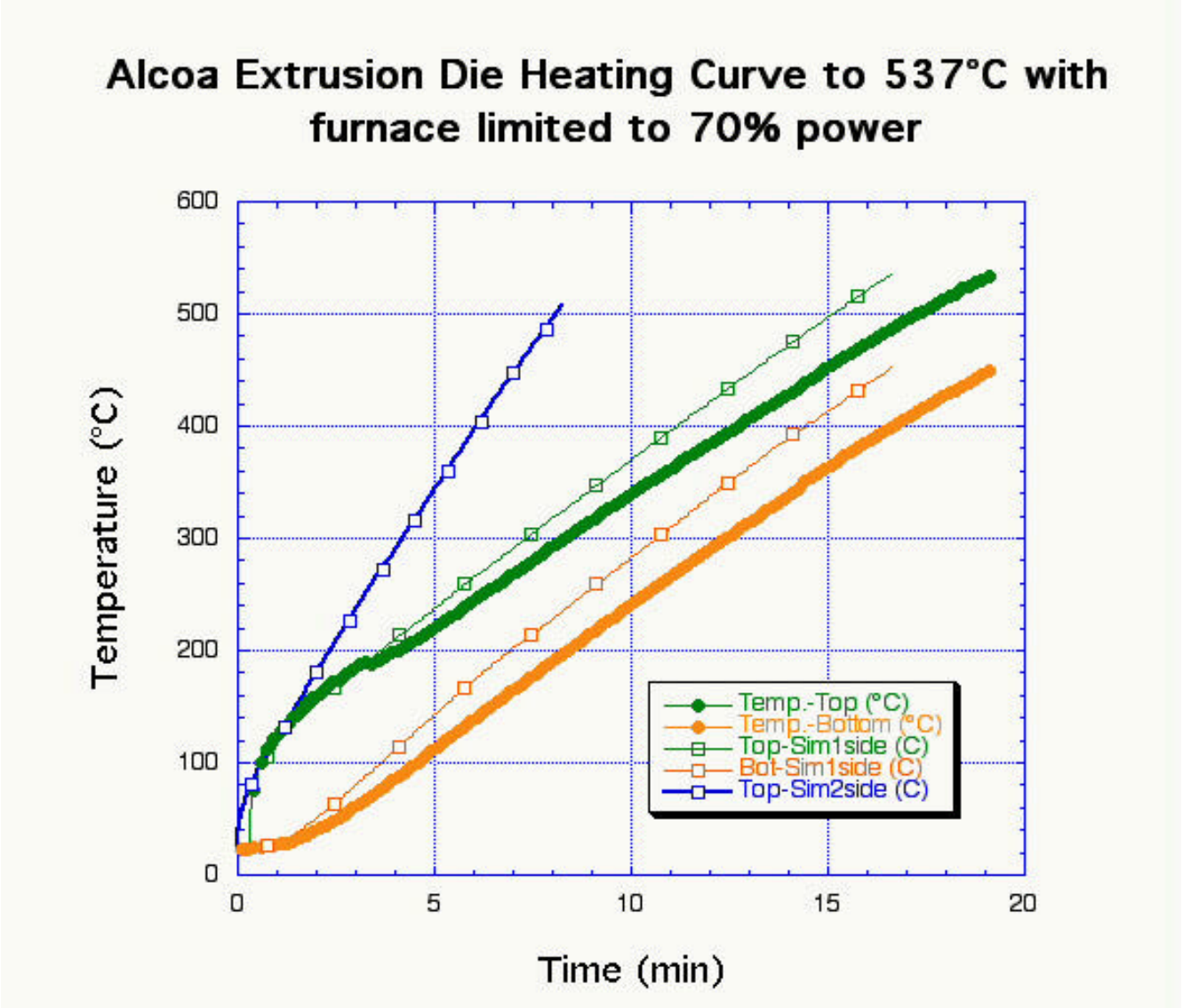


One sided heating at 90% power, front and back side thermal couples

IR Heating Able to Preheat 2” by 19” Die to Operating Temperature in 18 Minutes

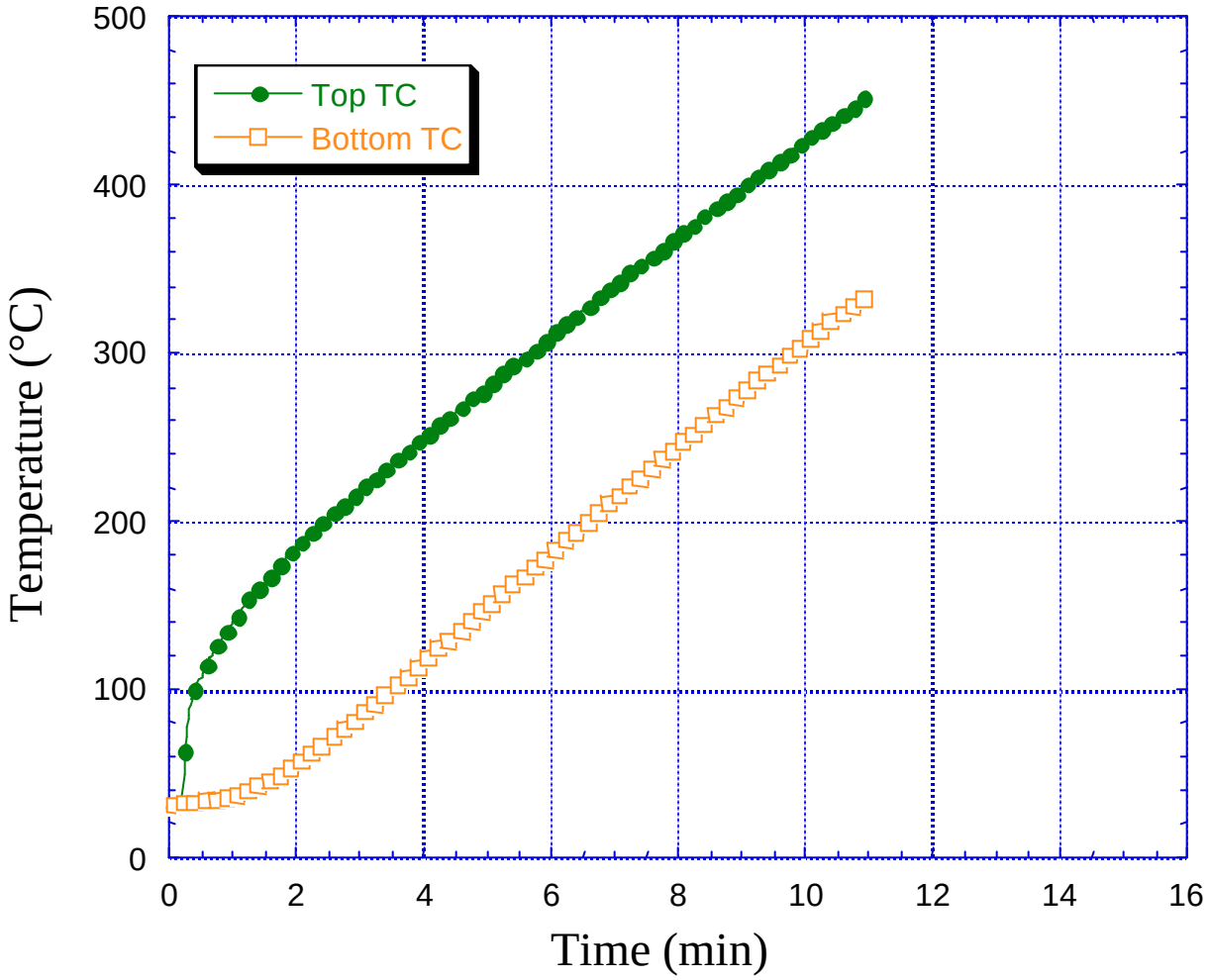


One sided heating at 70% power, front and back side thermal couples

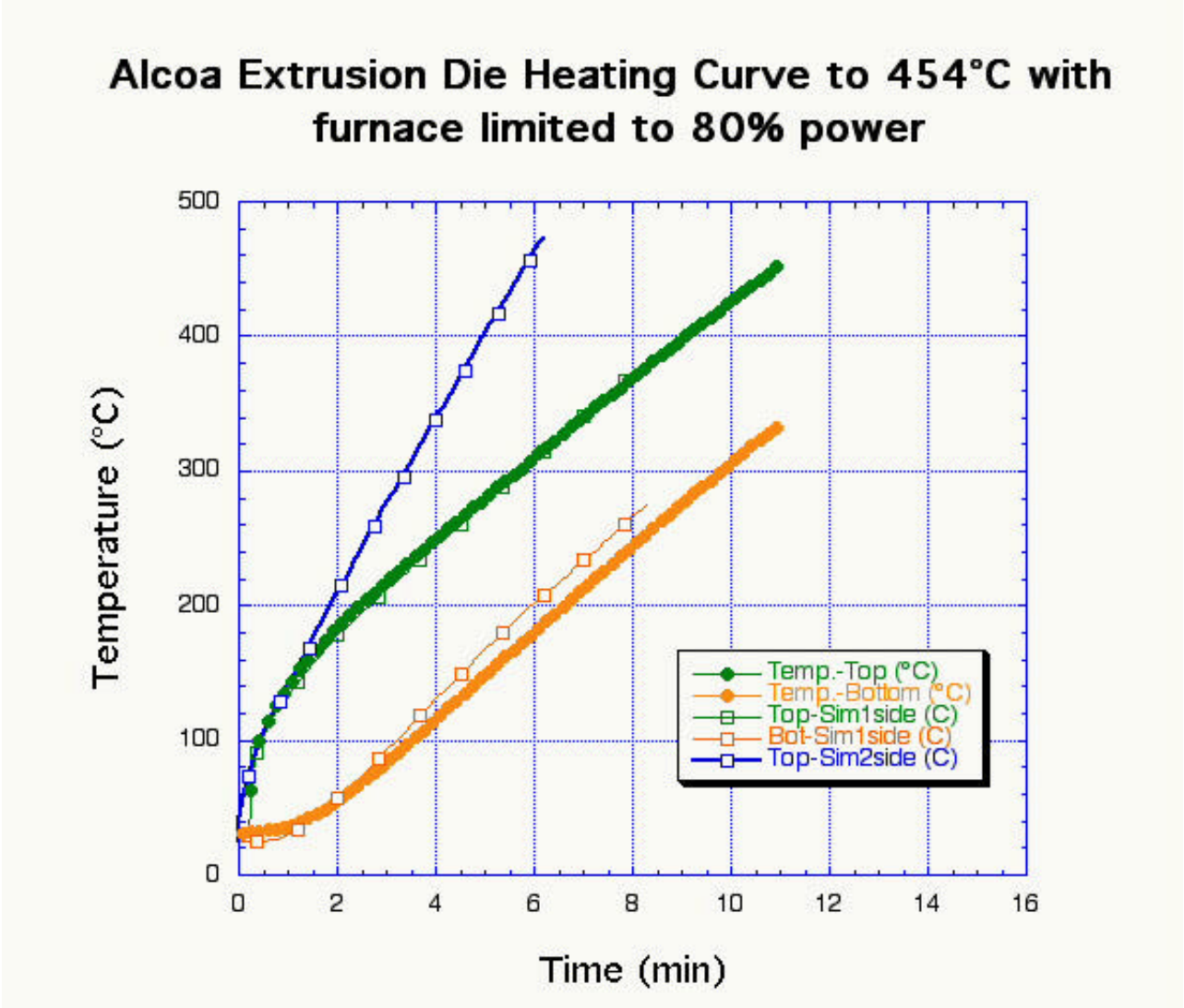


Experimental one sided heating at 70% power, front and back side thermal Couples, modeled front and back side, and modeled two sided heating, 2” thick by 19” diameter die.

IR Heating Able to Preheat 2” by 19” Die to Operating Temperature in 11 Minutes

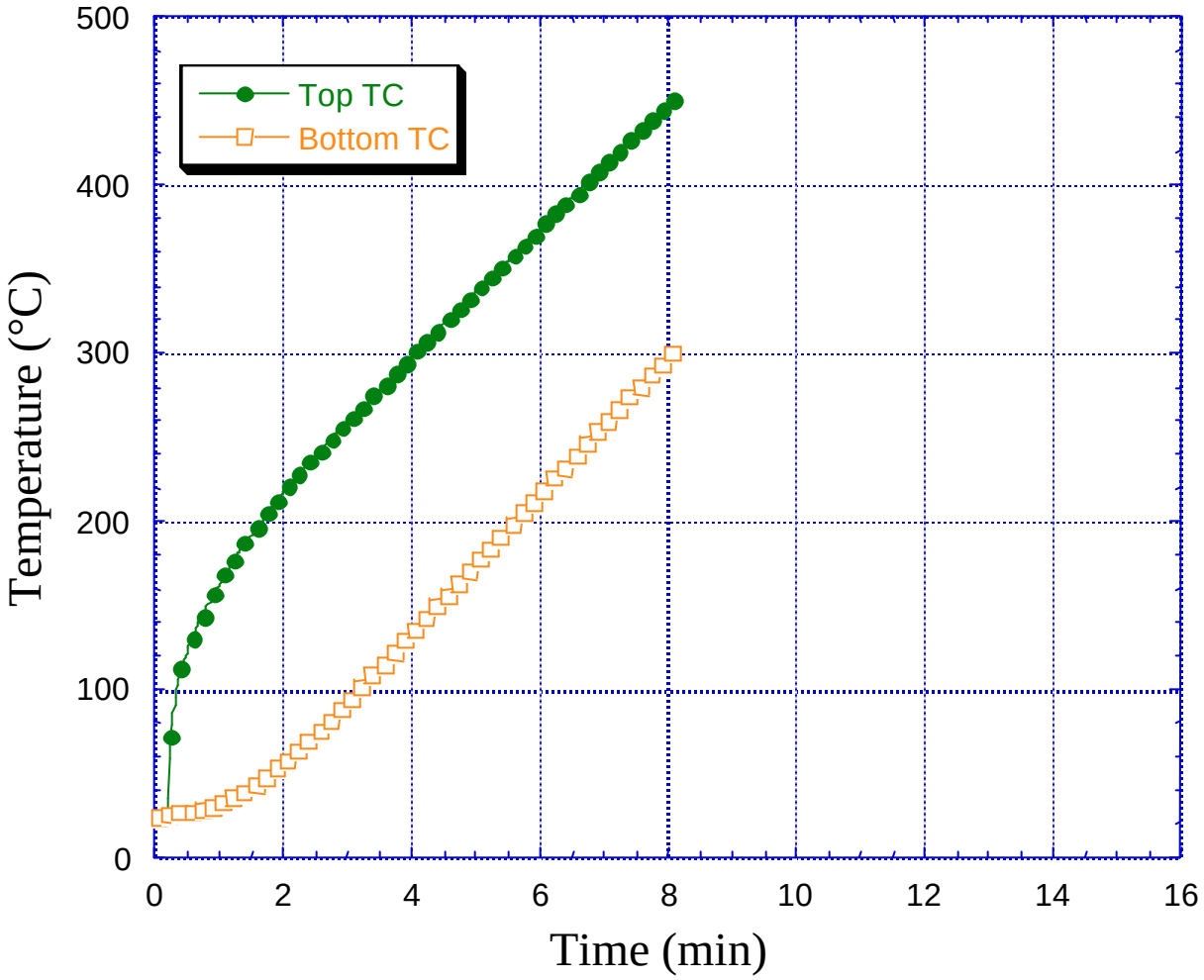


One sided heating at 80% power, front and back side thermal couples

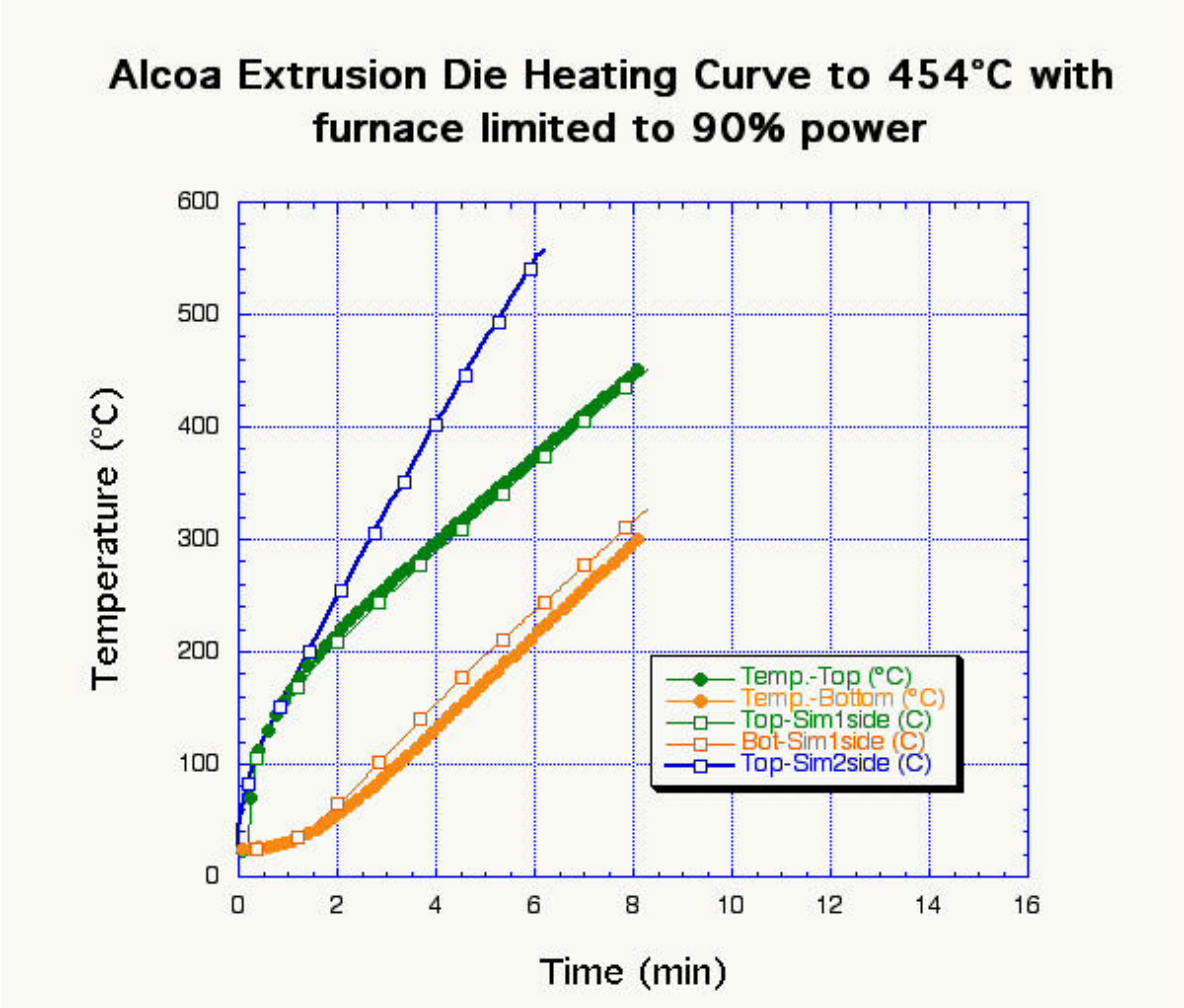


Experimental one sided heating at 80% power, front and back side thermal Couples, modeled front and back side, and modeled two sided heating, 2” thick by 19” diameter die.

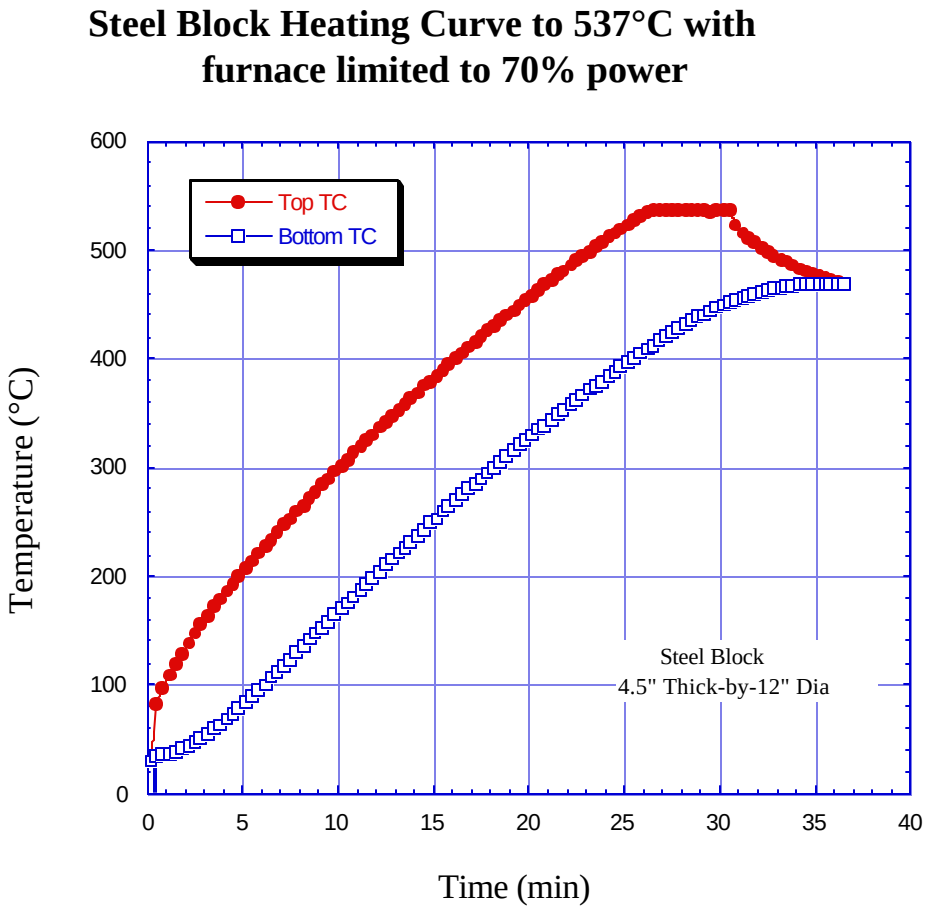
IR Heating Able to Preheat 2” by 19” Die to Operating Temperature in 8 Minutes



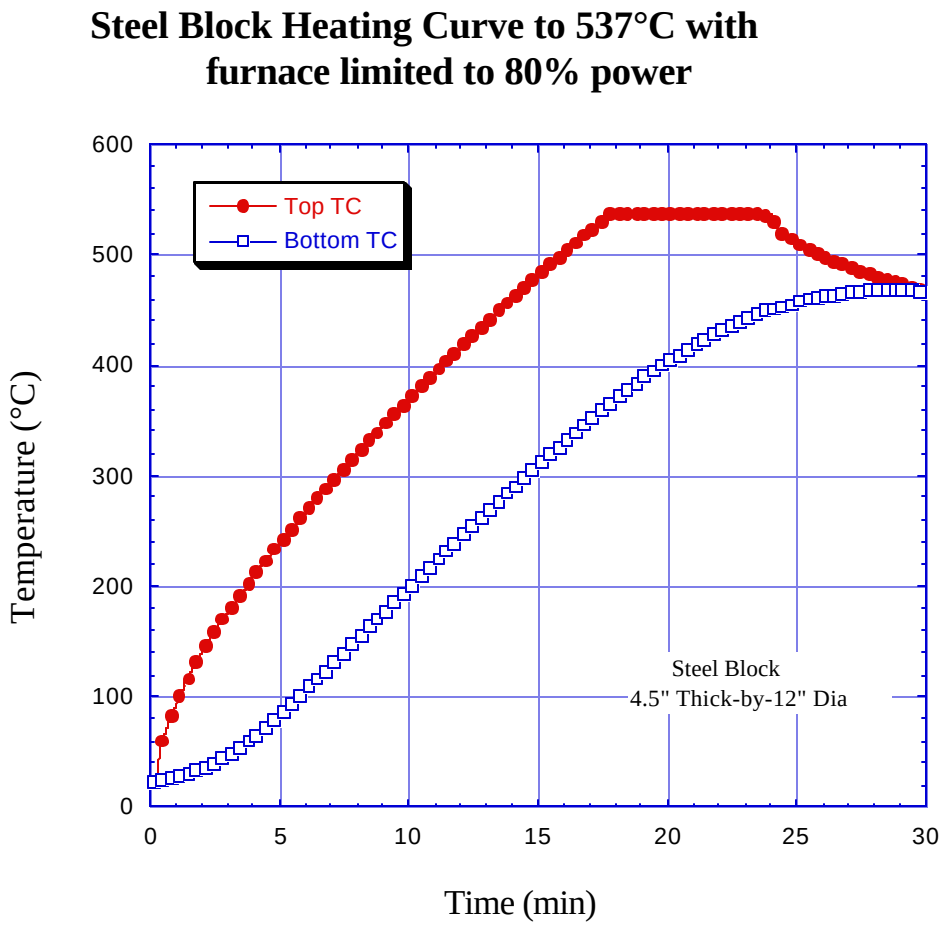
One sided heating at 90% power, front and back side thermal couples



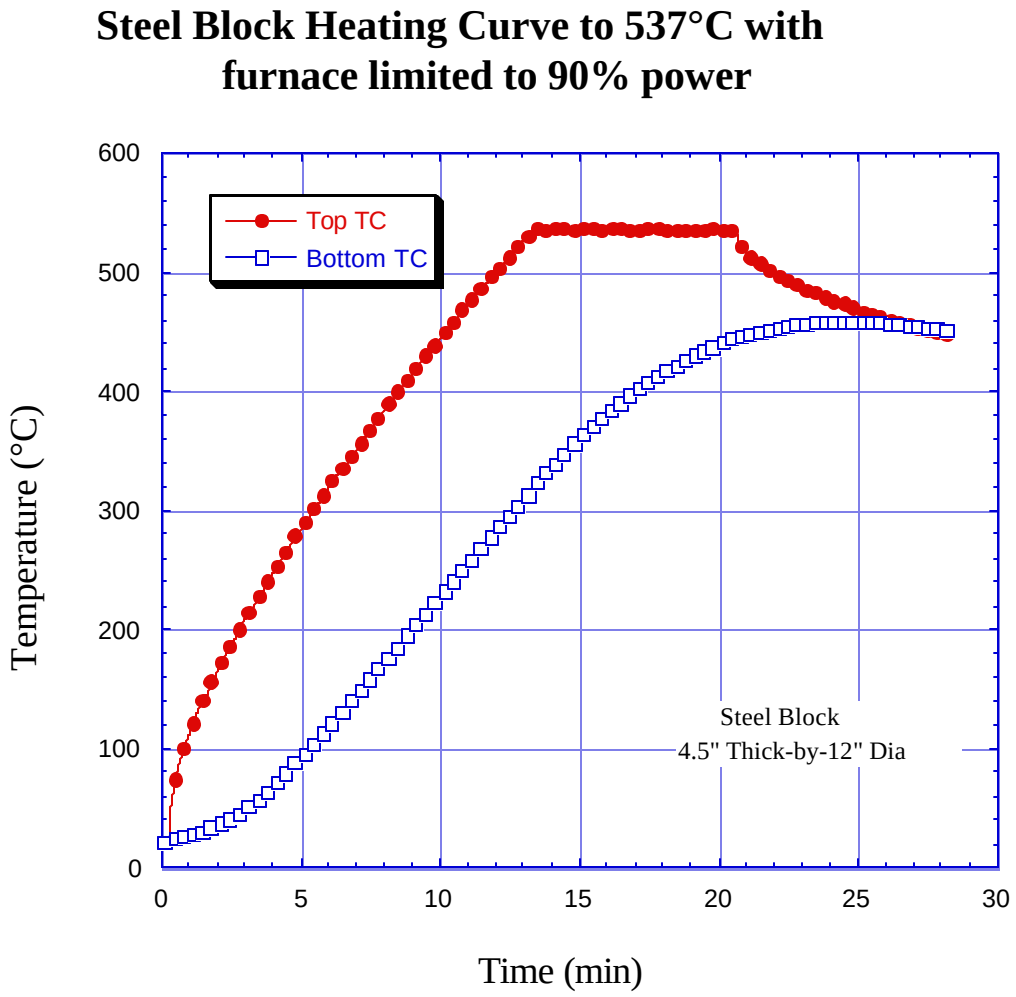
Experimental one sided heating at 90% power, front and back side thermal Couples, modeled front and back side, and modeled two sided heating, 2” thick by 19” diameter die.



Experimental one sided heating at 70% power, front and back side thermal Couples, modeled front and back side, and modeled two sided heating, 4.5” thick by 12” diameter die.

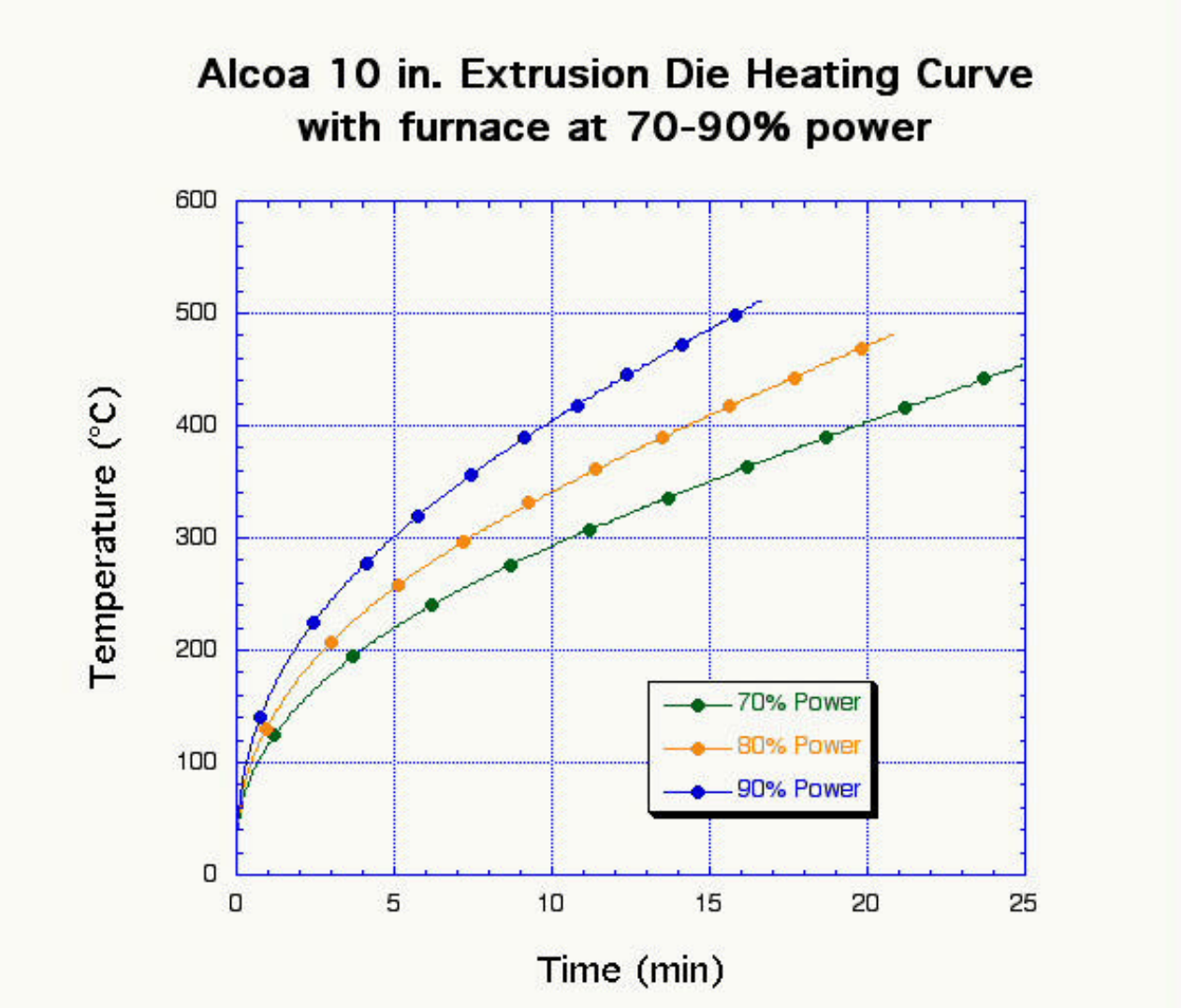


Experimental one sided heating at 80% power, front and back side thermal Couples, modeled front and back side, and modeled two sided heating, 4.5” thick by 12” diameter die.



Experimental one sided heating at 90% power, front and back side thermal Couples, modeled front and back side, and modeled two sided heating, 4.5” thick by 12” diameter die.

Two Sided Heating Model Reveals that a 10” by 18” Die Can be Heated to Operating Temperature in Less than 30 Minutes



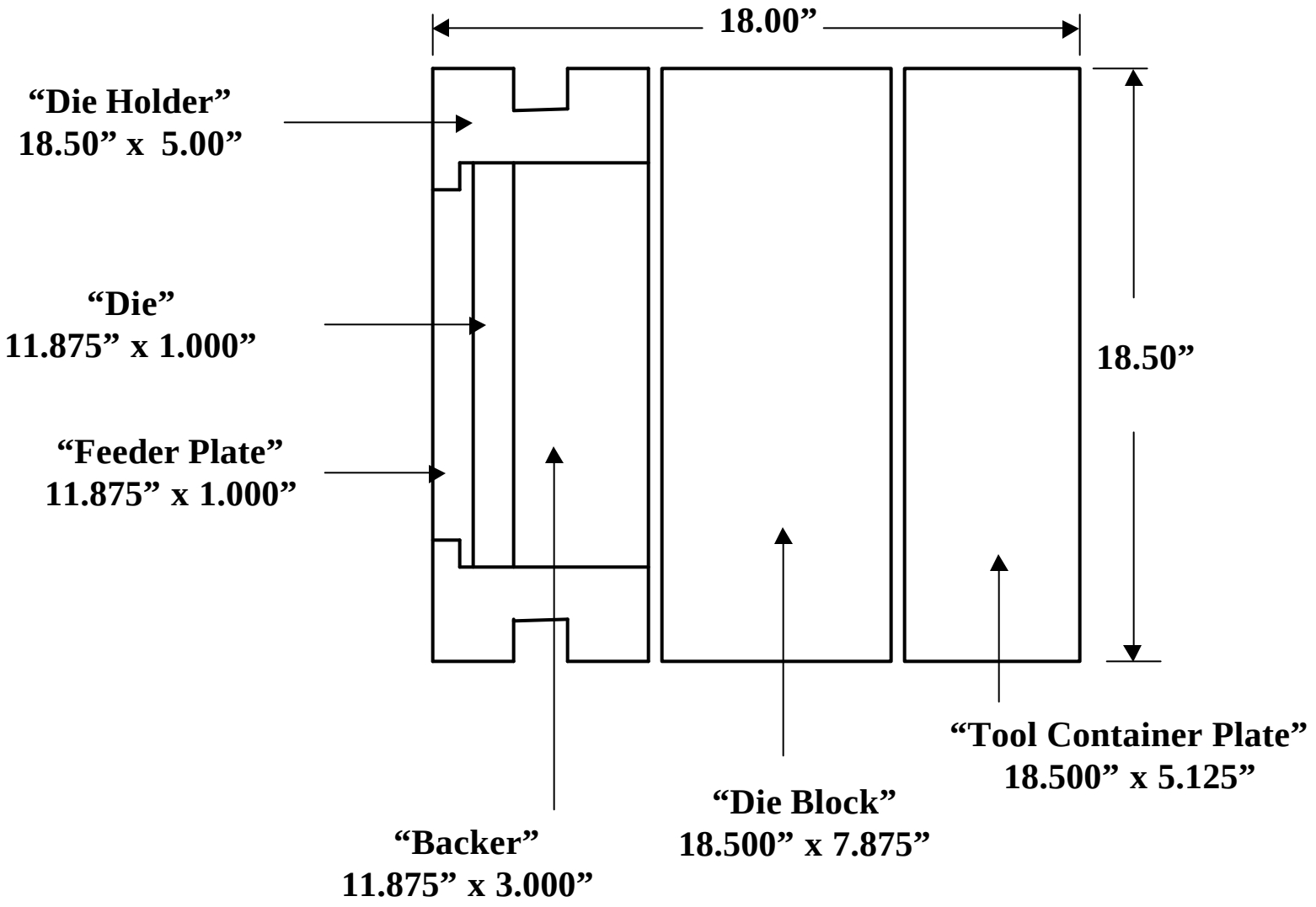
Full Scale Heating Profiles with Non-optimized Furnace

Due to the interest in heating a full extrusion die stack by Alcoa, two separate experiments were performed.

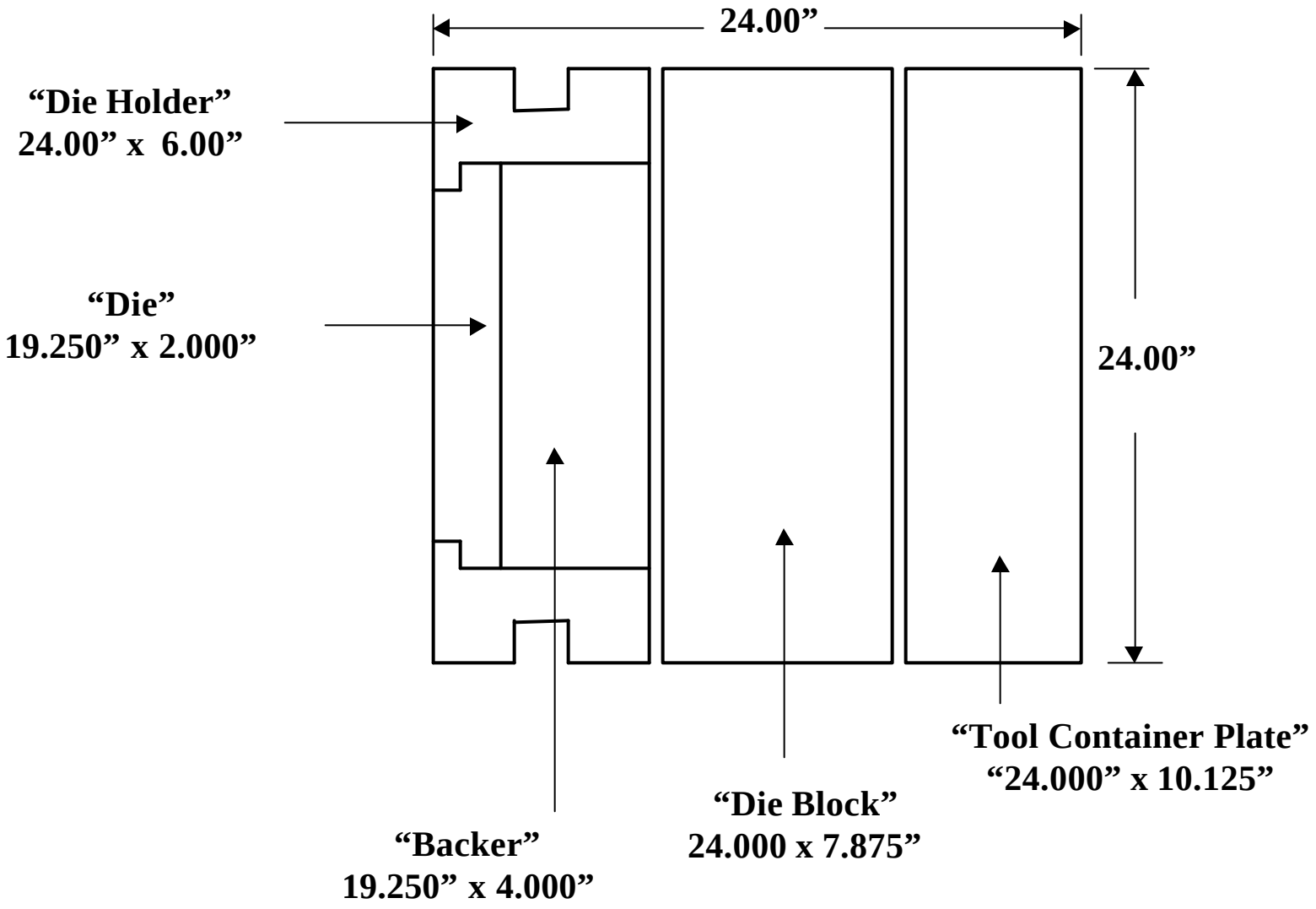
This was done knowing the times would be large but still multiple hours less then existing heating technology.

As seen in the heating data, due to the single sided heating, the furnace cuts back to 40% power only after heating 10 minutes.

Press 21
(Direct - 3000 Ton Press)

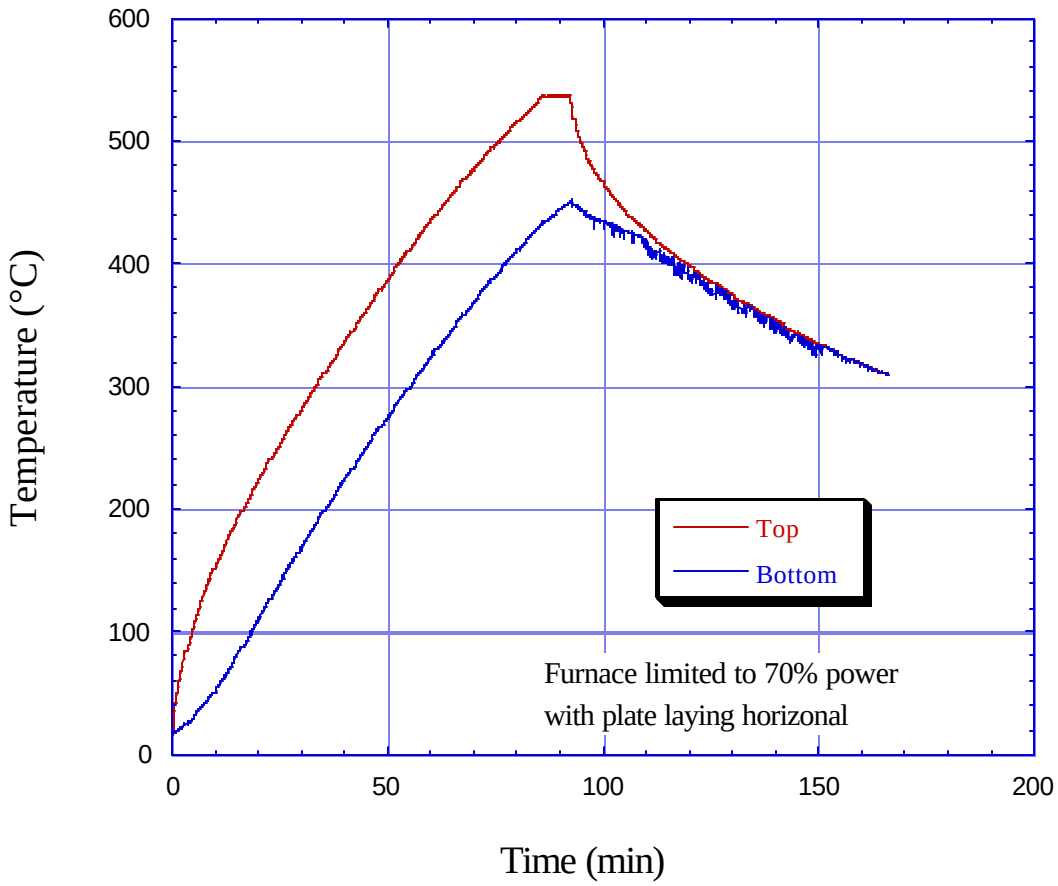


Press 22
(Direct - 4250 Ton Press)



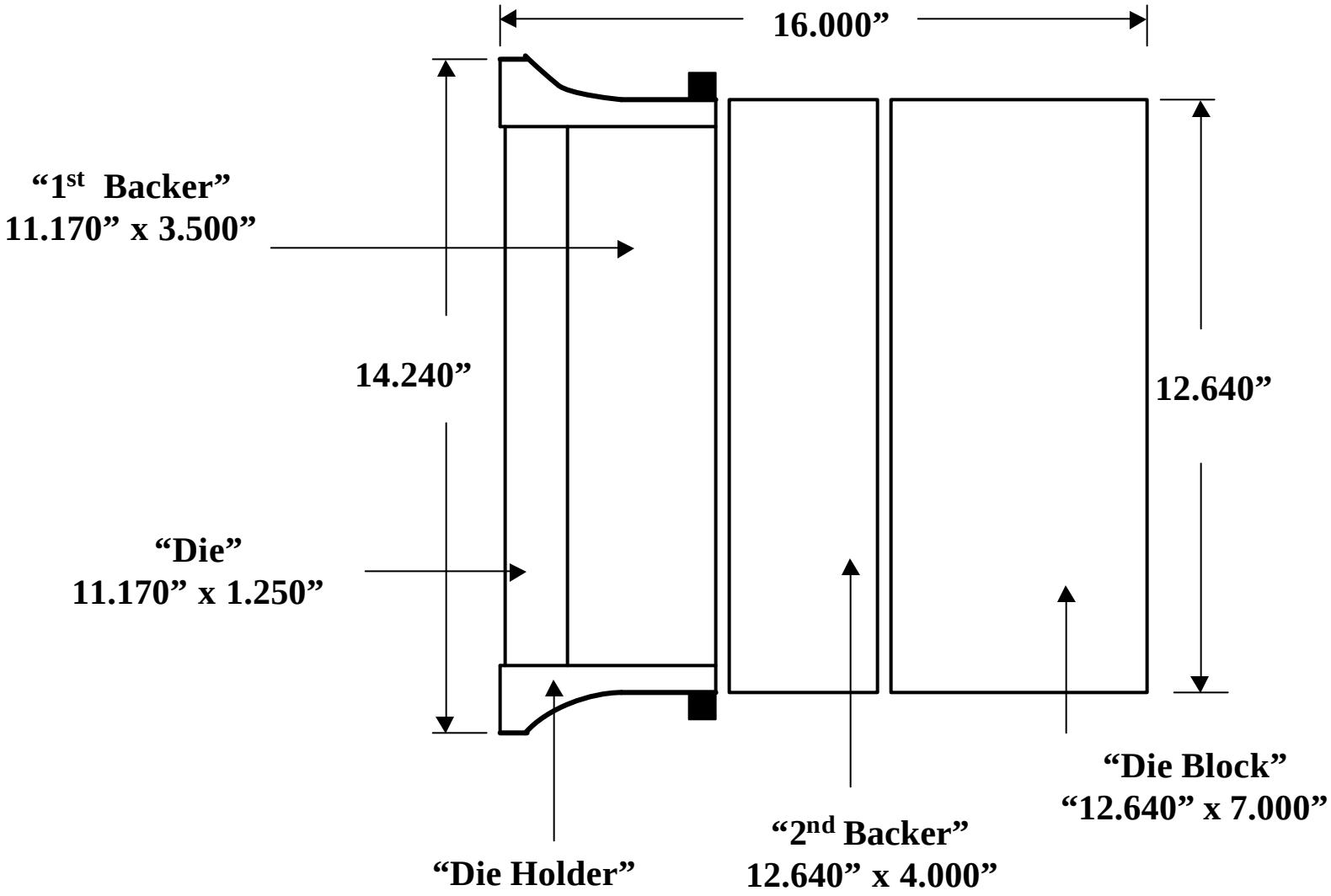
Press 22
(Direct - 4250 Ton Press)

Temperature profile for Alcoa Direct 4250 Ton Tool Container Plate 24" X 10.125"

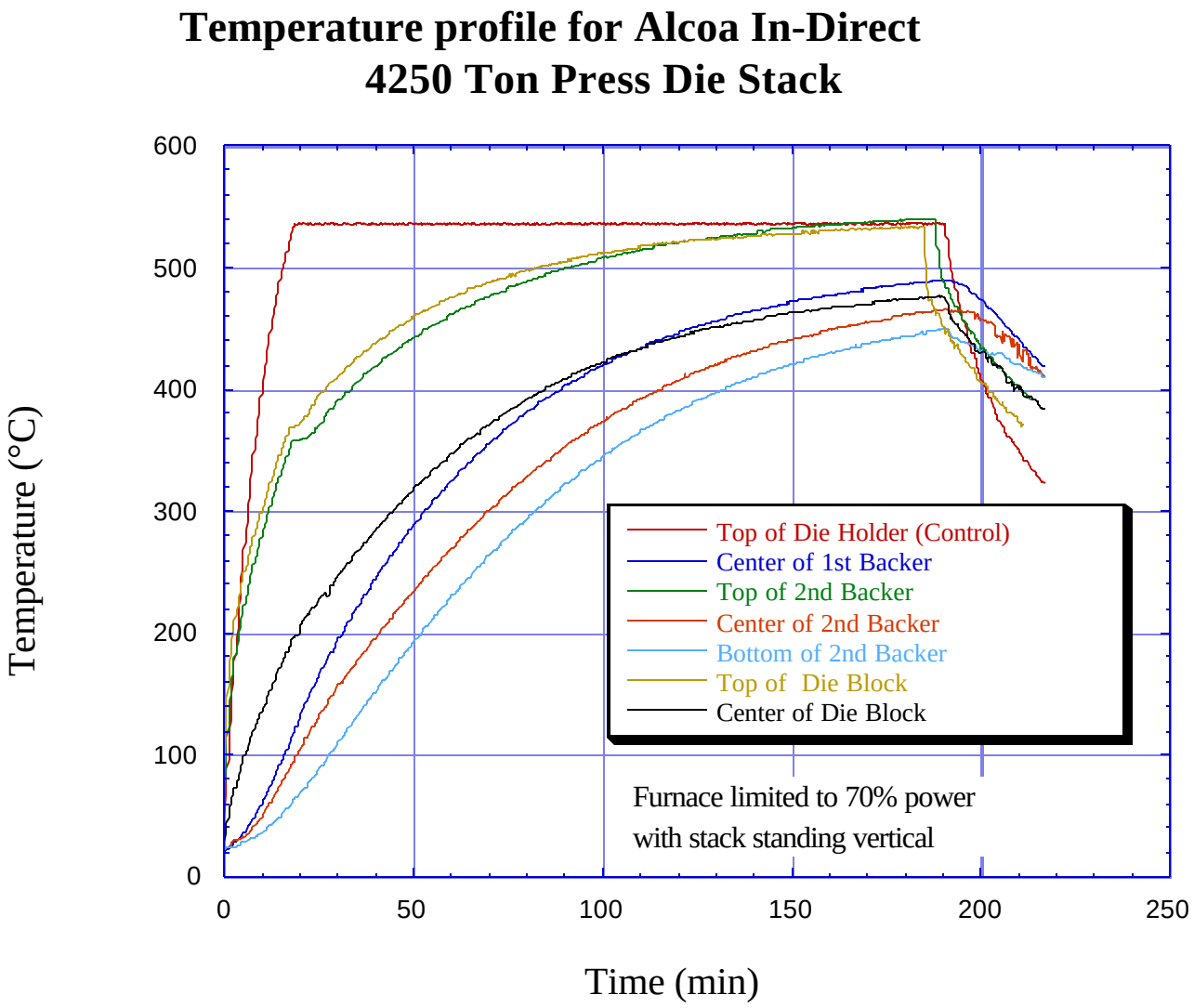


Just the tool container plate was run do to size limitations of our furnace. With one sided heating, the tool was brought to temperature in less than an hour and a half at 70% power.

Press 22
(In-Direct - 4250 Ton Press)



Press 22
(In-Direct - 4250 Ton Press)



Press 22
(In-Direct - 4250 Ton Press)

The entire tool stack was heated from one side with our existing 88 kW furnace at ORNL. Shown here are the dies being loaded in our existing drop bottom furnaces.

Press 22
(In-Direct - 4250 Ton Press)

The entire tool stack was heated from one side with our existing 88 kW furnace at ORNL. As seen, the dies are much too large to fit in the existing setup.

Photos of the setup are shown in the following slides.

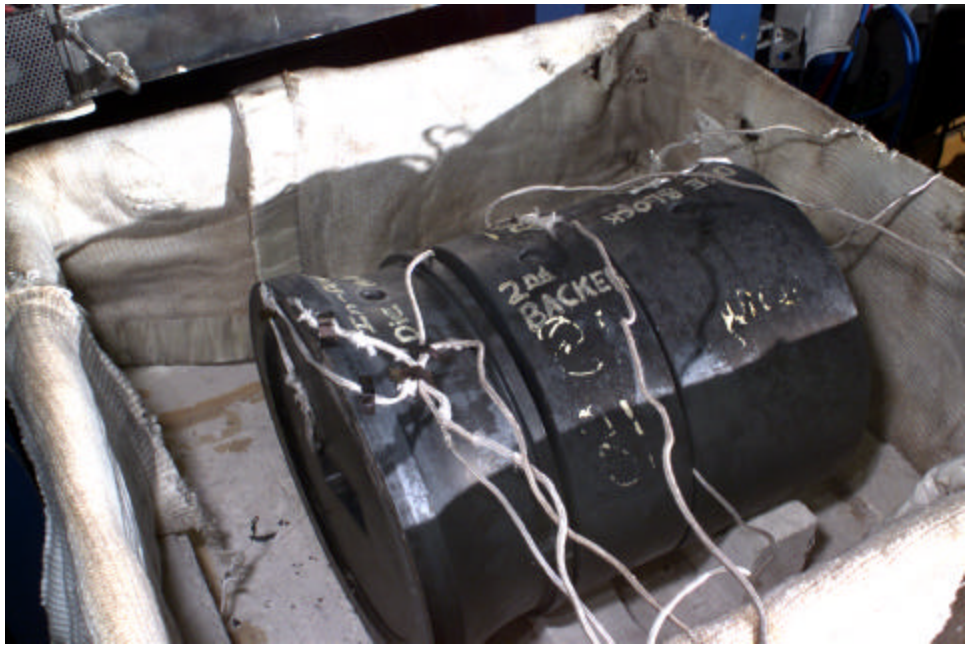
Press 22
(In-Direct - 4250 Ton Press)

The entire tool stack was heated from one side with our existing 88 kW furnace at ORNL with some modification to accommodate the large dies..

Press 22
(In-Direct - 4250 Ton Press)

The entire tool stack was heated from one side with our existing 88 kW furnace at ORNL.

With one sided heating, the tool was brought to temperature utilizing 70% power.



Press 22
(In-Direct - 4250 Ton Press)

The entire tool stack was heated from one side with our existing 88 kW furnace at ORNL.

With one sided heating, the tool was brought to temperature in less than three hours at 70% power. Again, this is in a non-optimized furnace and was performed at Alcoa's request.

IR Heating Provides Real Time Heating of Dies for Tool Changing

IR Single Sided Heating

- Preheats 1” by 18” dies to 820 F in 3.5 minutes

- Preheats 2” by 18” dies to 820 F in 8 minutes

- Experimental and modeling heating results match well.

IR Double Sided Heating Model

- Preheat 10” by 18” dies to 820 F in less than time needed for tooling change.

- Initial Prototype design capable of heating entire die stack in less than 30 minutes completed.