Time Dependance of Wire and Tank Wall Cool Down Rate using Lumped Capacitance Method

Wire Material:	304 V	
Tank Material:	9% Nickel steel	
Thermal Conductivity of 304 s/s:	12	W/(m-K)
Thermal Conductivity of 9% Ni:	21	W/(m-K)
Assumed Convection Coefficient	200	W/(m2-K)
Charactistic Lengths:		
Wire (r/2)	0.00015	m
Tank Wall (Wall Thickness)	0.0508	m
Biot Number, Bi hLc/k		
Wire	0.0025	
Tank Wall	0.4838095	

Conclusions:
The lumped capacitance method is very valid for the wire as the Bi number is << 0.1
The lumped capacitance method is not valid for the tank wall as the Bi number is greater than 0.1

Fourier Number, Fo alpha * t/Lc^2		
Alpha values:		
304 V	3.95	
9% Nickel steel	23	
Densities: Rho (kg/m3)		
Wire	7900	kg/m3
Wall	7950	kg/m3
Specific Heat, c (J/kg-K)		
Wire	477	J/kg-K
Wall	445	J/kg-K
Time Constants, rho*Lc *C /h		
Wire	2.826225	
Wall	898.5885	
Temperatures, K		
Temperature of Gas	87	K
Initial temperature	300	K
Assumed intermediate temperatur	140	K
nat log (theta/theta initial)	3.9648052	
Time to intermediate temperature, seconds = nat log (theta/theta init) * the time constant.		
Wire	11.205432	seconds
Wall	3562.7283	seconds

Conclusion:

This is highly dependant on the convection coefficient chosen. 200 w/m2 is for forced gas convection. Free gas convection is in the range of 5 to 25 W/m2. Boiling is in the range of 2500 to 100,000 W/m2. The bottom of the tank will initially see high convection heat transfer due to the rapidly vaporizing LAr. The top of the tank will see a low convection coefficient due to the relatively low gas velocity in the larger open area. The intermediate value of 200 W/m2 was chosen as an average and clearly indicates that the wires will cool down much more rapidly than the tank shell.