Multiple Heat Transfer Processes of a Tea Brewing System: Theoretical and Experimental Investigations

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water to an integrated reservoir; the water is then heated by coils and flows through the system to brew the tea. The hot tea then flows out of the system, through the spout, and is cooled by ice in the decanter.

This paper discusses th

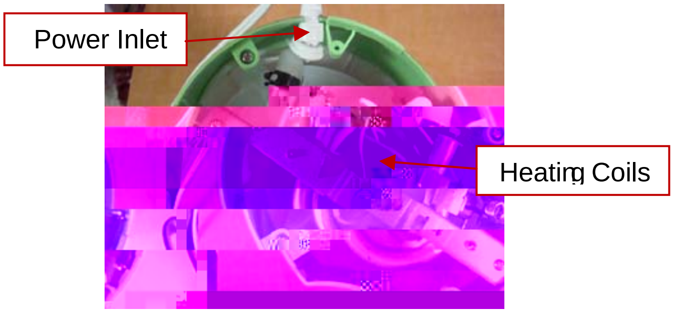


Figure 3: Heating coils of Iced Tea Maker

Three heat transfer processes are identified in this system, as shown in Figure 4: (1) tap water flows through a tube heated by coil; (2) hot water passes through a transition tube that is surrounded by tap water; and (3) the tea is mixed with ice cubes in a decanter to reach a thermal equilibrium.

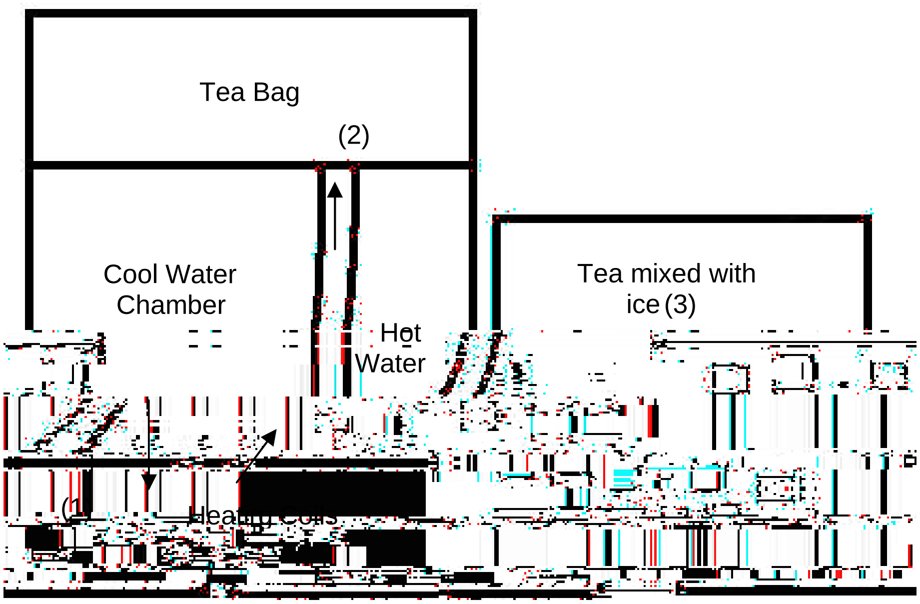


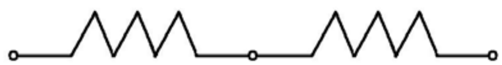
Figure 4: Schematic of Heating and Cooling Processes

Mathematical Models

1. Internal flow with constant surface flux

In the first process, the problem can be simplified as a water flow with a constant surface heat flux, as shown in Figure 5. Assuming the uniform flux and steady-state conditions, the mean temperature out of the coils can be calculated as follows

L_{tube} - length of the transition tube,
- outlet temperature of the water through the tube, and
U is the overall heat transfer coefficient, which can be calculated from a thermal circuit as shown in Figure 7.



Thermal resistances in Figure 7 can be calculated as follows,

The mass flow rate of the system can be determined assuming a tea brewing process of 10 minutes for the 1.18 kg of water

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Table 2 and Table 3 display the measured geometries of the decanter and of the transition tube.

Table 2: Measured Values of the Decanter

r_1	r_2	L
m	m	m
0.0746	0.0762	0.18

Table 3: Measured Values of the Transition Tube

$r_{1,tube}$	$r_{2,tube}$	L_{tube}
m	m	m
0.005	0.00635	0.23