Google Reactor Calibration Model

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This note is to describe the parameters and formula Google IPB Reactor Calibration Model.

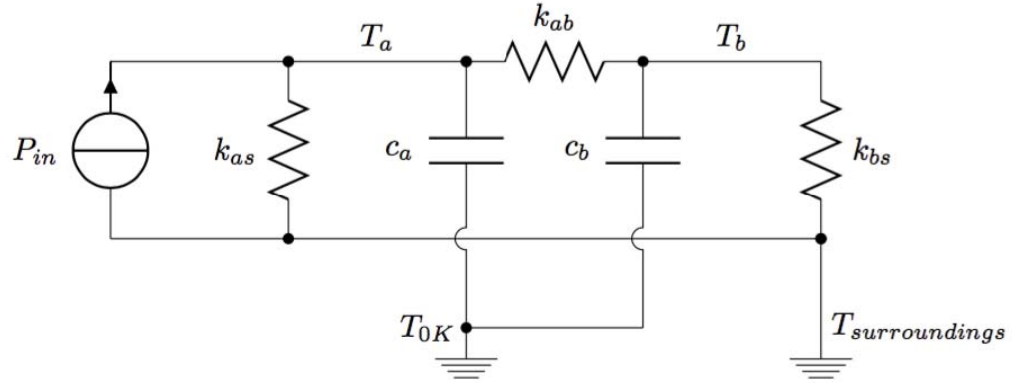The proposed equivalent circuit model is described in Figure 1.

Figure 1: Circuit Model

The governing equations are:

$$\frac{dT_a(t)}{dt} = \frac{P_{in} - k_{as}(T_a - T_s) - k_{ab}(Ta - T_b)}{c_a} \tag{1}$$

$$\frac{dT_b(t)}{dt} = \frac{P_{in} - k_{ab}(T_a - T_s) - k_{bs}(Tb - T_s)}{c_b} \tag{2}$$

The parameters in the equations are:

$$k_{as} = (k_{as0} + k_{as1}T_a + k_{as2}T_a^2) \tag{3}$$

$$k_{ab} = (k_{ab0} + k_{ab1}T_a + k_{ab2}T_a^2) \tag{4}$$

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$$k_{bs} = (k_{bs0} + k_{bs1}T_b + k_{bs2}T_b^2) \tag{5}$$

$$c_a = (c_{a0} + c_{a1}T_a + c_{a2}T_a^2) \tag{6}$$

$$c_b = (c_{b0} + c_{b1}T_b + c_{b2}T_b^2) \tag{7}$$

$$P_{in}(t) = (a_{10} + a_{11}T_a + a_{12}T_a^2)P_{heaterpower} + (a_{20} + a_{21}T_a + a_{22}T_a^2)P_{core-Q} \tag{8}$$

in DC P_{core-Q} is P_{DC}

T_a is the core temperature
T_b is the inner block temperature
T_s is the outer block temperature

$$P_{out}(t) = k_{as}[T_a(t) - T_s(t)] + k_{bs}[T_b(t) - T_s(t)] \tag{9}$$

$$P_{stored}(t) = c_a\frac{dT_a(t)}{dt} + c_b\frac{dT_b(t)}{dt} \tag{10}$$

The Energy COP defined as

$$COP_{energy}(t) = \frac{\int_0^t [P_{out}(t) + P_{stored}(t)]dt}{\int_0^t P_{in}(t)dt} \tag{11}$$

The Power COP defined as

$$COP_{power}(t) = \frac{P_{out}(t) + P_{stored}(t)}{P_{in}(t)} \tag{12}$$

The Google Team has done four calibration models, the table 1. lists all the parameters in the calibration models.

Table 1: Parameters in Google Model

Parameters	ipb1-30b-he	ipb1-30b-h2	sri-ipb2-27b-h2	sri-ipb2-33b-he
ca0	10.58	52.91	17.19	20.59
ca1	0.4303	0.2200	-0.6768	0.0857
ca2	-0.0009	-0.0003	0.0086	0.0000
cb0	601.10	579.90	883.48	675.09
cb1	0.4669	0.3826	-2.7510	0.1209
cb2	0.0000	0.0000	0.0000	0.0000
kas0	0.0292	0.0266	0.0001	0.0017
kas1	-0.0001	0.0000	0.0002	0.0000
kas2	0.0000	0.0000	0.0000	0.0000
kab0	0.6535	0.6192	0.8300	0.5686
kab1	-0.0005	0.0008	-0.0024	0.0008
kab2	0.0000	0.0000	0.0000	0.0000
kbs0	0.0330	0.0368	0.0753	0.0637
kbs1	0.0002	0.0001	-0.0003	0.0001
kbs2	0.0000	0.0000	0.0000	0.0000
a10	1.0000	1.0000	1.0000	1.0000
a11	0.0000	0.0000	0.0000	0.0000
a12	0.0000	0.0000	0.0000	0.0000
a20	0.3676	0.3598	0.4250	0.0505
a21	0.0010	0.0007	-0.0009	0.0031
a22	0.0000	0.0000	0.0000	0.0000