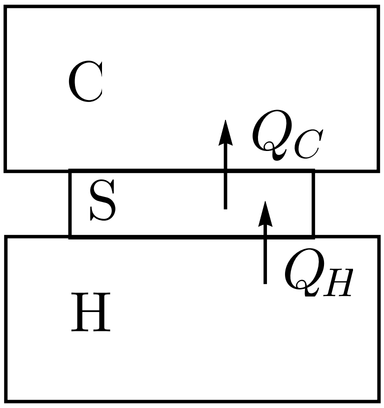
Benard Cell analysis

1 Schema

A simple Benard cell can be represented by three parts: the heater H, the cooler C much bigger than the system of interest S which is placed in between the two. The analysis usually goes along this lines: if the temperature difference between the heater and the cooler $\Delta \mathrm{T} = T_H - T_C$ is small then the heat transfer occurs by diffusion, however if the temperature difference a critical point a second mechanism, convection, engages in heat transfer.



Rysunek 1.
Benard cell schema; the heater and cooler are in thermal equilibrium.

2 Analysis

We'll analyze it from the perspective of internal entropy produced (i) and external entropy transferred (e) to the system of interest S. Of course entropy change of the system $đS_S$ would be the sum of those two:

$$\frac{đS_S}{đt} = \frac{đS_i}{đt} + \frac{đS_e}{đt} \tag{2.1}$$

In our analysis we'll limit ourselves to the scenario of a stable state in which the same amount of heat that goes in also goes out. In other words $Q_C = -Q_H$ and we get

$$đS_e = \frac{đQ_H}{T_H} + \frac{đQ_C}{T_C} = đQ_H\left(\frac{1}{T_H} - \frac{1}{T_C}\right) = đQ_H\left(\frac{T_C - T_H}{T_H\, T_C}\right) < 0 \tag{2.2}$$

Therefore the process transfers some of the entropy outside the system. However, since we require a stable state $đS_S = 0$ it leads us to the conclusion that $đS_i > 0$, so in a sense we could say that the rate of internal entropy production $đS_i$ is a function of the entropy inflow $đS_e$.

Before steady–state the inflow of entropy $đS_e$ might not be exactly balanced out by the internal entropy production. In fact, at first it's value we'll be positive if the system temperature is closer to the temperature of the cooler and negative if it's closer to the temperature of the heater.

Now we may make a weak association with information – since erase of information is associated with entropy production (due to Landauer), then we can say that at steady–state the amount of information stays constant, even though the it's inflow is non–zero (negative dS_e) it get's immediately erased by the non–zero internal entropy production (positive dS_i)

Critique

Problem jaki widzę, to to, że te równania są spełnione równania są spełnione również podczas dyfuzji, a więc nie mówią nam nic specjalnego o konwekcji i dlatego człon dS_i / dt nie może być utożsamiony z MEP...
e