

A well-insulated electric oven is being heated through its heating element. In figure 1, the entire oven, including the heating element, is taken to be the system. In figure 2, the system is taken as only the air in the oven without the heating element.

In both situations, determine whether this is a heat or work interaction. Explain.

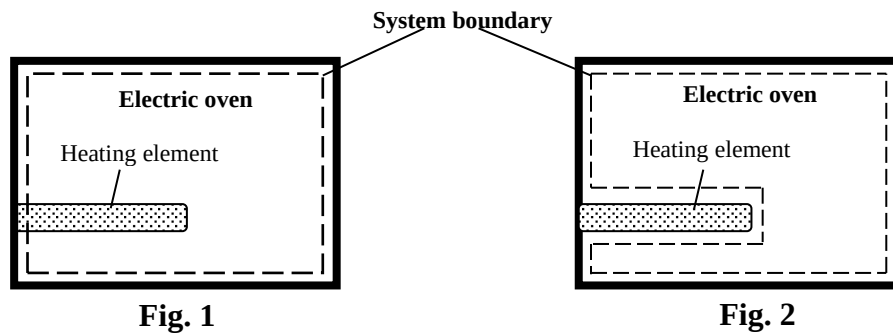


Fig. 1:

For this problem, the interior surfaces of the oven form the system boundary. The energy content of the oven obviously increases during this process, as evidenced by a rise of temperature. This energy transfer to the oven is not caused by a temperature difference between the oven and the surrounding air. Instead, it is caused by electrons crossing the system boundary and thus doing work. Therefore it is a work interaction.

Fig. 2:

This time, the system boundary includes the outer surface of the heating element and does not cut through it. Therefore, no electrons are crossing the system boundary at any point. Instead, the energy generated in the interior of the heating element is transferred to the air around it as a result of the temperature difference between the heating element and the air in the oven. Therefore, this is a heat transfer process.

Discussion:

For both cases, the amount of energy transfer to the air is the same. These two examples show that an energy transfer can be heat or work, depending on how the system is selected.