

# Principles of Microwave Oven

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**Abstract – We introduce principles of microwave oven. In other words, we say that how materials could be heat up by microwave of microwave oven. And we talk about attentions for safe using of microwave oven.**

## I . INTRODUCTION

Microwave oven is one of the most widely used household appliances. Most of homes and most of conveniences store and restaurants have microwave oven. The reason for its popularity is that it cooks food in an amazingly short amount of time. They are also extremely efficient in their use of electricity because a microwave oven heats only the food – nothing else. In this article, we'll discuss the mystery behind the magic of “meals in a minute” with microwave cooking.

## II. OPERATING PRINCIPLE OF MICROWAVE OVEN

A microwave oven uses microwaves to heat food. Microwaves are radio waves. In the case of microwave ovens, the commonly used radio wave frequency is roughly 2,500 megahertz (2.5 gigahertz). Radio waves in this frequency range have an interesting property : they are absorbed by water, fats and sugars. When they are absorbed they are converted directly into atomic motion and motion is converted into heat. Microwaves in this frequency range have another interesting property: they are not absorbed by most plastics, glass or ceramics. And metal reflects microwaves, which is why metals cause spark in a microwave oven. The reason that metal reflects microwaves is that no electronic waves resident in inside of conductor because conductor's conductivity is infinity as we studied in our course. The property in this paragraph is possible because the frequency 2,500 megahertz is resonance frequency of water.

Let's look at this in detail. Molecules of all food are consist of a dipole and have positive charge in one side and have negative charge in another side. If we put electromagnetic fields in this, all molecules are rearranged : + charge is to negative

pole and -charge is to positive pole. In this process molecules heat is produced by friction. The frequency of microwave oven is 2,500 megahertz as we saw before. Then microwave of this frequency change the direction of electromagnetic fields 2,500,000,000 times in 1 second. Consequently the heat efficiency of a microwave oven is greatly high.

You often hear that microwave ovens cook food “From the inside out.” What does that mean? If you bake a cake in a conventional oven, normally you would bake a cake at 350degrees F or so, but let’s say you accidentally set the oven at 600 degrees instead of 350. What is doing to happen is that the outside of the cake will burn before the inside even gets warm. In a conventional oven, the heat has to migrate (by conduction) from the outside of the food toward the middle. You also have dry, hot air on the outside of the food evaporating moisture. So the outside can be crispy and brown while the inside is moist.

In microwave cooking, the radio waves penetrate the food and excite water and fat molecules pretty much evenly throughout the food. There is no “heat having to migrate toward the interior by conduction”. There is heat everywhere all at once because the molecules are all excited together. There are limits of course. Radio waves penetrate unevenly in thick pieces of food (they don’t make it all the way to the middle), and there are also “hot spots” caused by wave interference, but you get the idea. The whole heating process is different because you are “exciting atoms” rather that “conducting heat”.

In a microwave oven, the air in the oven is at room temperature, so there is no way to form a crust. That is because it heats up foods by ‘microwaves’ instead of ‘heat conduction’.

### III. ADVANTAGES AND DISADVANTAGES

ADVANTAGES	DISADVANTAGES
<ul style="list-style-type: none"> <li>- Cooking time is short</li> <li>- Destruction of nutrients is less</li> <li>- No physical change of foods</li> <li>- Melting process is easy</li> <li>- Sterilization effect exists</li> <li>- There is no flame, then treatment is easy</li> </ul>	<ul style="list-style-type: none"> <li>- Constraint with metal container</li> <li>- Heat force control is difficult</li> <li>- Water evaporation</li> <li>- Closed container is dangerous because it could be burst</li> <li>- Surface toasting is impossible</li> </ul>

#### IV. ATTENTIONS IN USING MICROWAVE OVEN

1. If the container is metal spark is generated and no foods heat up.
2. If food is different in ingredients heating velocity could be different. For instance the food contained more fat will be heat up fastly.
3. Bad influence to human body of microwave in microwave oven is nearly only the thermal effect. And safe level of microwave is  $10\text{mW}/\text{cm}^2$ . Leakage of microwave is mostly occurred in the gap of oven and door. Therefore it is important to pay attentions that gap length is not differed.

#### V. CONCLUSION

In this article we presented about operating principles of microwave oven. And also presented advantages and disadvantages of microwave oven, and presented attentions in using microwave oven. Microwave oven is amazing household appliance to heat up foods by using microwaves. This Microwave has frequency equals the resonance frequency of water. Therefore foods could be heat up by oscillation of water molecules.

#### REFERENCES

- [1] 손중철, “식품과학과 산업”, vol 32, no 1, pp2, Jan, 1999
- [2] 이홍우, “전자레인지 원리 및 구조”, 한국조리과학회지, vol 5, no.1 , pp 85, Jan.1989.

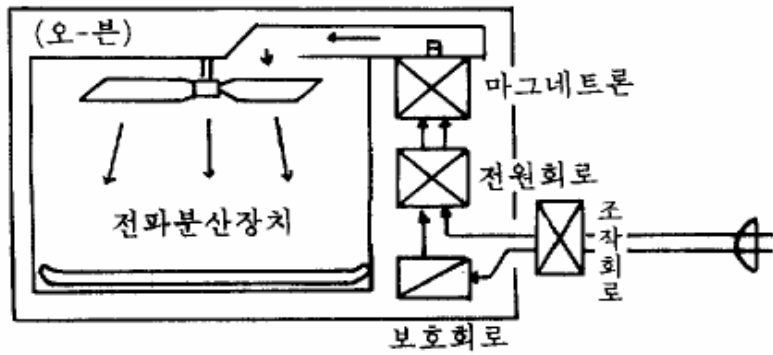


Fig. 1. Fundamental building blocks.

- Power Supply
- Magnetron
- Cavity
- Control Part

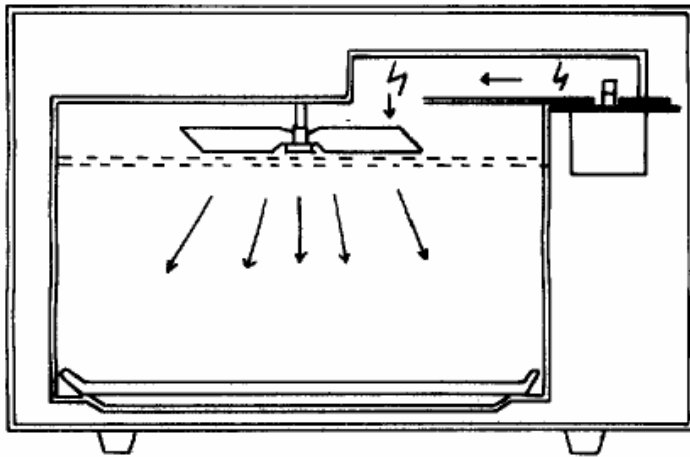


Fig 2. Type 1 : Stirrer Type

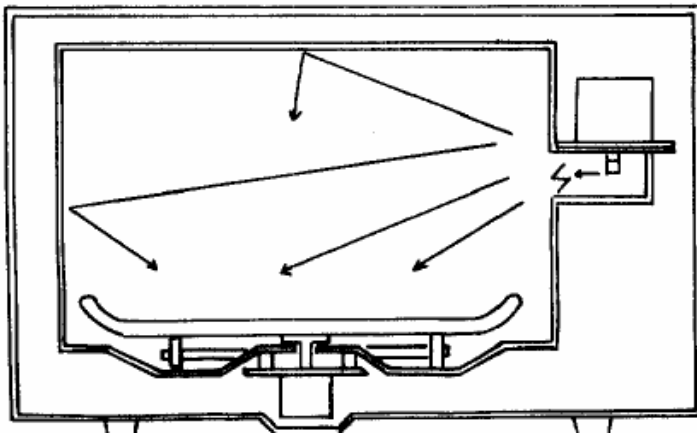


Fig 3. Type 2 : Turn Table Type