

Sub Name:FOOD PROCESSING AND PRESERVATION

Sub Code: C-10

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PRINCIPLES OF MICROWAVE HEATING

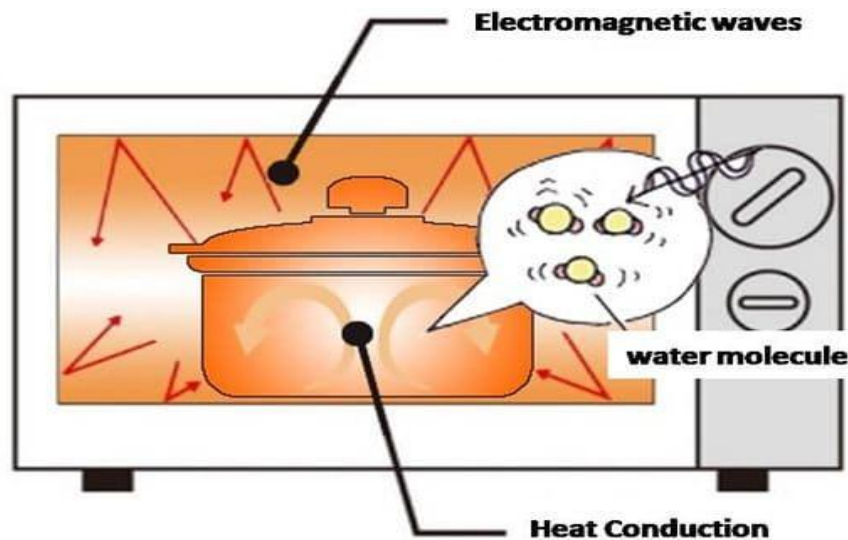
INTRODUCTION

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

OPERATING PRINCIPLE OF MICROWAVE OVEN

As known, microwave oven uses non-contact heating by converting the electromagnetic energy into heat.

Traditional cooking methods suggest heat input to the food surface. Further heat is distributed inside due to heat conduction. The heating food process in a microwave oven differs fundamentally. In this case, heat is generated inside the food using water molecules.



The principle of microwave is transferred the electrical energy and friction to heat or cook the food.

Therefore, the rate of volumetric heating by microwaves is significantly higher.

The microwave radiation does not cause chemical changes in food and preserves from 75 to 98 % of the vitamins in food. For comparison, conventional heat treatment ensures the preservation of only 35-60%.

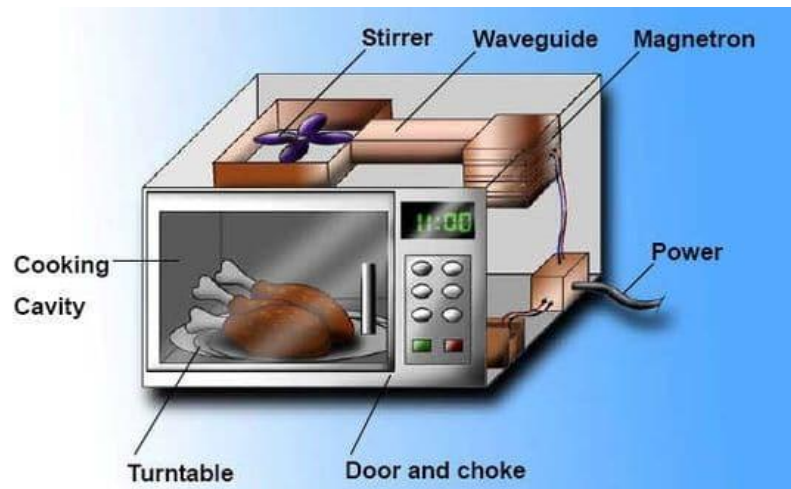
Main components

Microwave contains:

1. operating chamber with screened door;
2. high-voltage transformer for power supply of magnetron;
3. switching circuit and control;
4. magnetron to generate microwave radiation;

5. waveguide for transmitting radiation from magnetron to chamber.

This scheme demonstrates their traditional placement.

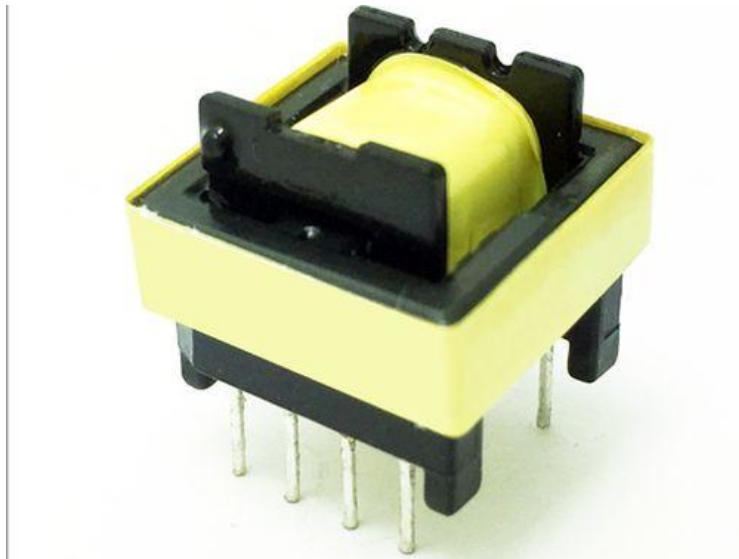


Auxiliary elements:

1. turntable increases the heating uniformity;
2. control circuit;
3. fan for cooling the magnetron and ventilation of chamber.

Operation process

The microwave generator is called magnetron and is the main element of device. Special transformer – stabilizer is the most expensive element.



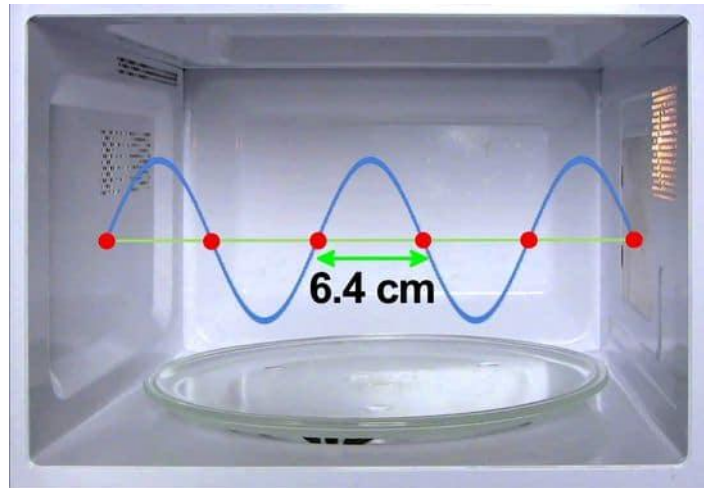
It provides power to the magnetron. Its nominal operating voltage on high-voltage winding is 2100-2300 V, rated voltage of primary winding is 3-3.2 V. But it's absent in modern inverter microwave ovens, which use a different principle of magnetron power control.

High leakage inductance on the high-voltage winding and special design of the magnetic circuit with magnetic shunts is a hallmark of such transformers. They provide stability high voltage. This value is changed by only 1.2 % at fluctuation of supply voltage on 10 %.

Individual elements of the magnetic circuit are welded together for ensuring the quiet transformer operation. Accumulating a high-voltage capacitor with a capacitance from 0.8 to 1.2 μF is calculated to operate at a voltage up to 10 kV.

A rectangular waveguide is used as a line for transmission of power from a magnetron to the emitter. The emitter provides RF power in the working chamber. Design of the emitter and waveguide provides the matching between a working chamber and magnetron. Emitter excites a wide range of wave types in chamber for ensuring a heating uniformity.

Working chamber is a hollow rectangular resonator. The dimensions of the inner walls are much larger than the wavelength. Electromagnetic waves are repeatedly reflected in the chamber from its walls and form numerous standing waves of the electromagnetic field with the nodes and tufts.



Food heat treatment

Intensity of the electromagnetic field in chamber is increased to a level of absorption of microwave power by food. Spot food heating is proportional to the square of effective value for electric field strength at a given point.

Engineers provides optimal superposition of standing waves for maximum uniformity of the heating food. But, unfortunately, the perfect heating uniformity is impossible due to significant variations of dielectric properties and form of food and cookware. Therefore, this problem is solved by additional methods.

These include:

- microwave turntable for foods;
- superposition of the antenna rotation axis with the axis symmetry of working chamber;
- asymmetrical shape of the radiation pattern;
- rotating impeller with metal blades, which performs the function of a microwave flow stirrer;
- the use of two emitters from branched waveguide.

Microwave door

The door of the working chamber is very important part, because it prevents the spread of the microwave energy in kitchen. Therefore, the door design is quite complicated. The door has a high-frequency throttle shutter along the entire perimeter that reduces the microwave power to a safe value. Open slit of the throttle shutter is filled with a special plastic that efficiently absorbs microwave energy.



The door design provides a very snug fit to plane of front surface of working chamber. Established official requirements permit the gap not more than 0.5 mm. In this case, the energy flux density outside of microwave oven does not exceed the permissible level that is 2.1 mW / cm.

Features

Power control is usually carried out by changing the ratio durations of pauses and periods of generation magnetron. The absence of pauses corresponds to the maximum power. The equality between the pause duration and generation periods corresponds to a power level of 50%, etc. Magnetron operation is controlled through primary winding of the transformer.

All microwave ovens have a common feature. They are not designed for using the cookware with metal content due to risk forming the current induction. Induction current is accompanied by a sincere and can cause an arc discharge.

Control panel of modern models provide their programming and turns off device at violation of blocking door or at temperature increase of magnetron, transformer or in the working chamber. Controls include electromechanical dials, electronic buttons and touch panel.

ADVANTAGES AND DISADVANTAGES

ADVANTAGES	DISADVANTAGES
Cooking time is short	Destruction of nutrients is less
No physical change of foods	Constraint with metal container
- Melting process is easy	Heat force control is difficult
Sterilization effect exists	Water evaporation
There is no flame, then treatment is easy	Closed container is dangerous because it could be burst
	Surface toasting is impossible

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 $10\text{mW}/\text{cm}^2$.
4. 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.