2. PREPARATION FOR ROASTING

2.1 Types of roasters

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MAIN TYPES OF ROASTERS

DRUM ROASTER

- The beans are roasted in a rotating drum, with a high percentage of conduction.

FLUIDIZED BED CONVECTION ROASTER

- Uses hot air to circulate around the beans, creating a boiling layer and ensuring even heating and roasting on all sides.

CONVECTION DRUM ROASTER

- Combines the advantages of both types of roasters.

SAMPLE ROASTER

- Designed for roasting samples, most often electric and air.

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DRUM MATERIAL

MATERIAL	THERMAL CONDUCTIVITY	HEAT CAPACITY	FEATURES
Cast iron parts	Low	High	Takes a long time to warm up and retains heat well
Stainless steel	Low	Low	Scorching risk, price
Carbon steel	Average	Average	Universal

Thermal conductivity is the ability of a material to conduct heat. Materials with high thermal conductivity quickly transfer heat energy from one part to another, making them effective for use in cooling and heat capacity systems.

Heat capacity is the amount of heat required to heat a body by one degree. Materials with high heat capacity require more energy to heat, but they can also store more thermal energy. This property is important for materials used in heat storage or transportation systems.

ROASTING ON GAS

PROS

Precise temperature control

Gas burners allow you to quickly adjust the heat level, which is especially important at different stages of roasting.

Economy

In regions with inexpensive gas, this method may be cheaper to operate.

Wider temperature range

Suitable for experimenting with different roasting profiles.

Wider temperature range

Many roasters prefer gas for its "natural" heat transfer.

CONS

Instability of supply

Gas quality and pressure can vary, which will affect roasting results.

Difficulty of installation

Reliable ventilation and strict safety requirements are required.

Environmental restrictions

Gas roasters are less environmentally friendly and may be banned in some areas.

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ELECTRIC ROASTING

PROS

Stability

Electric roasters provide precise and even heat distribution.

Ease of use

Easier to install, no gas lines or ventilation required.

Eco-friendliness

A more environmentally friendly option, especially when using renewable energy sources.

Ease of management

Often equipped with digital controllers for fine-tuning roasting profiles.

CONS

Power limitation

Electric machines may have less power, making it difficult to roast large batches.

High cost of electricity

In some areas, electric roasters may be more expensive to operate than gas roasters.

Environmental restrictions

Electricity can be less flexible for creating extreme roast profiles.

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2. PREPARATION FOR ROASTING

2.2 Types of energy

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TYPES OF ENERGY

CONDUCTION

- The transfer of heat from one object to another through direct contact. In coffee roasting, this occurs between the beans and the surface of the equipment.

CONVECTION

- The process of transferring heat through the movement of hot air. During coffee roasting, hot air circulates around the beans, ensuring a fast and even roast.

RADIATION

- Radiation is the transfer of energy without a directed air flow and without contact. Energy transfer occurs due to the heat of metal parts and burner elements.

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CONDUCTION

— is a method of heat transfer during coffee roasting in which heat is transferred directly from the hot drum to the coffee beans through contact and partly through contact between the beans.

Features of conductive roasting:

- Slower energy and less penetrating.
- The speed of rotation of the drum affects
- Makes coffee more vibrant

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CONVECTION

- is a method of heat transfer during coffee roasting, in which heat is transferred to the beans through the constant passage of hot air.

Features of convective roasting:

- Even roasting
- More efficient and stable
- The roasting process is faster

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RADIATION

— is a method of transferring heat without direct contact with the source. This method does not play a key role in coffee roasting, but understanding it is important to fully catch the process.

Radiation features:

- difficult to control
- does not have a key influence
- accumulates in materials

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TYPES OF BURNERS

ATMOSPHERIC BURNERS

provide uniform heating of beans due to natural air flow. Well controlled due to modulation. In atmospheric burners the ratio is shifted towards conduction, which makes coffee sweeter.

TURBO BURNERS

are equipped with a fan for forced air injection into the combustion zone. This allows to increase flame intensity and temperature, and also ensures faster and more uniform heating of beans. In turbo burners, the energy balance is shifted towards convection, which makes the taste slightly less bright, but more predictable.

INFRARED BURNERS

These burners allow you to work more with radiation energy. They are more efficient and make coffee cleaner due to the technology of mixing and burning gas and reducing combustion products that get into the drum.

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ROASTING ON GAS

PROS

Precise temperature control

Gas burners allow you to quickly adjust the heat level, which is especially important at different stages of roasting.

Economy

In regions with inexpensive gas, this method may be cheaper to operate.

Wider temperature range

Suitable for experimenting with different roasting profiles.

Wider temperature range

Many roasters prefer gas for its "natural" heat transfer.

CONS

Instability of supply

Gas quality and pressure can vary, which will affect roasting results.

Difficulty of installation

Reliable ventilation and strict safety requirements are required.

Environmental restrictions

Gas roasters are less environmentally friendly and may be banned in some areas.

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ELECTRIC ROASTING

PROS

Stability

Electric roasters provide precise and even heat distribution.

Ease of use

Easier to install, no gas lines or ventilation required.

Eco-friendliness

A more environmentally friendly option, especially when using renewable energy sources.

Ease of management

Often equipped with digital controllers for fine-tuning roasting profiles.

CONS

Power limitation

Electric machines may have less power, making it difficult to roast large batches.

High cost of electricity

In some areas, electric roasters may be more expensive to operate than gas roasters.

Environmental restrictions

Electricity can be less flexible for creating extreme roasting profile.

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2. PREPARATION FOR ROASTING

2.3 Loggers

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LOGGERS

– these are devices or software that allow you to record and monitor key roasting parameters in real time.

They record temperature, time, rate of temperature change (or ROR - Rate of Rise) and other important data that helps us analyze the roasting process and repeat successful profiles.

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MAIN FUNCTIONS OF LOGGERS

TEMPERATURE CONTROL

The logger must be able to record the temperature at different points of the roaster - inside the drum, on the surface and in the hot air zone. And draw graphs of these temperatures.

ROR (RATE OF RISE) RECORD

Loggers that ROR record of bean and air help to see and analyze the intensity, stability of roasting, and the transition from endothermic to exothermic.

CHARTS AND ANALYSIS

The logger should be able to plot graphs, save the required profile and beans parameters, provide the ability to analyze and compare results, test and record tasting results, set reference roasting profiles and control points.

SUPPORT FOR DIFFERENT ROSTERS

It is important that the logger can integrate with your equipment and support all the necessary parameters, see all the sensors and, ideally, have the ability to adjust all the parameters.

2. PREPARATION FOR ROASTING

2.4 Roasting defects

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ROASTING DEFECTS

DEFECT	VISUALLY	SENSORY	REASONS	HOW TO AVOID
Overroasted	Too dark	High bitterness	High drop degree, long development, too long roast profile	Reduce the charge temperature, reduce development
Underroasted	Too light	High acidity, raw, green	High ROR at crack, short development, low temperature rise after crack	Increase drop temperature, approach 1 crack less intensively
Scorching	Partially scorched	Smoky notes	High charge temperature, too intense roasting, low drum rotation speed	Reduce roasting power and drop temperature, increase drum rotation speed
Tipping	Dark spots on the bean	Slightly smoky	High airflow, too intense roasting	Reduce airflow power, reduce roasting intensity
Baked	The surface is lighter than the core.	Muted, dull, cardboard	Not enough energy at the beginning or after 1 crack	Increase charge temperature and roasting intensity, without reducing it before and during the 1st crack

OVERROASTED

Overroasted beans are easy to recognize by their appearance: they are darker than they should be, and the taste of such coffee is bitter, with notes of charcoal or ash. Overroasting defect occurs when the temperature is too high or the roasting lasts too long.

How to avoid overroasting:

- Temperature control is the key. Overroasting often occurs at the last stages, due to too high charge temperature.
- Time control: too long overall time or too long development time after the first crack.

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UNDERROASTED

The bean has not had time to fully develop. Underroasted beans remain too light in color and their flavor is often described as grassy, “green,” or raw. This defect occurs when roasting is stopped too early or because the development time is too short.

How to avoid the "underroasted" defect:

- Watch the first crack. Underroasting often happens when the coffee is unloaded before the desired time or percentage of development has passed. The first crack is a signal for the roaster, but if the ROR is too high, we will get to the desired drop temperature too quickly, and the coffee will be underroasted.
- Modulation at the start: if the coffee is dense and moist and we have not set the right amount of energy at the start, the temperature increases too slowly and the bean may not receive enough heat for its final development.

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SCORCHING

Scorching appears as black spots on beans. It occurs when the beans are in contact with heated surfaces, or more precisely, with the drum longer, causing scorching. Moisture evaporates in part of the bean and it is the first to char.

How to avoid scorching defect:

- Adjust the speed of the drum. If the drum rotates too slowly, the beans remain in contact with the hot surface of the drum longer, causing scorching.
- Modulation during loading. Scorching most often occurs when the drum is overheated. Due to too high modulation of the burner or too long heating.
- charge temperature: charge temperature that is too high may cause scorching.

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TIPPING

Embryo scorching - the tips of the beans are scorched. Tipping occurs because the embryo has a different density and is the first to be affected by temperature. In the taste, as in other defects associated with scorching. shades of bitterness and ash can be detected.

How to avoid tipping:

- Gradual increase in temperature. The initial stages of roasting should be smooth so that the beans are heated evenly. Too sharp increase in modulation can lead to the following.
- Airflow Control: If the convection is not set up correctly, it can cause parts of the beans to overheat. Make sure the airflow is evenly distributed throughout the roaster.

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BAKED

Baked is described as not bright enough, dull, cardboard-like. Baked beans may be lighter on the outside than on the inside. In fact, the surface has stopped developing and caramelizing due to lack of energy, while the inside of the beans has continued to develop.

How to avoid the "Baked" defect:

- The final stage. Enough energy is close and after the first crack starts, the taste development will not stop.
- Control in the medium stages: Enough energy during roasting for full caramelization and Maillard's reaction will help to avoid baking.

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DEFECTS "HOW TO ROAST"

SCORCHING

1. **Preheat the drum to 220-230 degrees**
2. **Roast coffee with high burner modulation at the beginning (intense)**
3. **Reduce drum speed by 20%**
4. **Reduce air pressure to 40-60Pa**

↘

- Total time 9-11 minutes
- ROR at the beginning of roasting 25-30 degrees per minute
- Increase after crack 9-10 degrees
- Development time 1-30
- ROR on crack is 7 degrees per minute
- Percentage of development - 13-14

If everything went correctly, the result is:
Roast color - standard (90-100 Lighttells)
Weight loss - standard (13-15%)
Visual effect - burnt spots on the beans
Effect in the cup - smoke, charcoal

In theory, your goal is to achieve visual charring of the beans by roasting them too intensely.

DEFECTS "HOW TO ROAST"

TIPPING

1. **Preheat the drum to 220-230 degrees**
2. **Roast coffee with high burner modulation at the beginning (intense)**
3. **Enlarge Airflow 140-160 Pa**
4. **Increase drum speed by 20%**

↘

- Total time 8-9 minutes
- ROR at the beginning of roasting 25-30 degrees per minute
- Increase after crack 9-10 degrees
- Development time 1:30
- ROR on crack is 7 degrees per minute
- Percentage of development 13-14

If everything went correctly, the result is:
Roast color - standard (90-100 Lighttells)
Weight loss - standard (13-15%)
Visual effect - black dots on the tip of the beans, the embryo has turned black
Effect in the cup - smoke, charcoal

Theoretically: Your task is to obtain a dull "burning" of the embryo due to high pressure and air temperature

DEFECTS "HOW TO ROAST"

BAKED

1. **Preheat the drum to 160-180 degrees**
2. **Roast coffee with low-medium burner modulation at the beginning**
3. **Standard drum rotation speed**
4. **Standard Airflow**

↘

- Total time 10-12 minutes
- ROR at the beginning of roasting 15-20 degrees per minute
- Increase after crack 8-10 degrees
- Development time 2:00
- ROR on crack is 4-5 degrees per minute
- Percentage of development 13-14

If everything went correctly, the result is:
Roast color - standard (90-100 Lighttells)
Weight loss - standard (13-15%)
Visual effect - the core of the beans is lighter than the surface
Effect in the cup - dull, muted, cardboard

In theory: Your goal is to produce a dull, muted coffee with a roast profile that is too long and not enough energy in the final roast stage.

DEFECTS "HOW TO ROAST"

OVERROASTED

1. **Preheat the drum to 200 degrees**
2. **Roast coffee with normal burner modulation**
3. **Standard drum rotation speed**
4. **Standard Airflow**

↘

- Total time 10-11 minutes
- ROR at the beginning of roasting 20-25 degrees per minute
- Increase after crack is 10-12 degrees
- Development time 1:45-2:00
- ROR on crack is 7 degrees per minute
- Development percentage 14-16

If everything went correctly, the result is:
Roast color - dark (80-90 Lighttells)
Weight loss - above average (15+%)
Visual effect - dark color
Effect in the cup - increased bitterness, bitter

In theory, your goal is to get slightly over-roasted coffee due to the high temperature increase after crack.

DEFECTS "HOW TO ROAST"

UNDERDEVELOPED

1. **Preheat the drum to 200-220 degrees**
2. **Roasting coffee with high burner modulation**
3. **Standard drum rotation speed**
4. **Standard Airflow**

↘

- Total time 9-10 minutes
- ROR at the beginning of roasting 25-30 degrees per minute
- Increase after crack 10 degrees
- Development time 1:00
- ROR on crack 10 degrees per minute
- Percentage of development 10-12

If everything went correctly, the result is:
Roast color - light (95-105 Lighttells)
Weight loss - below average (13-14%)
Visual effect - light color
Effect in the cup - underdeveloped acidity, sharp, sour

In theory, your goal is to get an underdeveloped flavor, with underdeveloped acidity and sweetness due to overdevelopment.

2. PREPARATION FOR ROASTING

2.5 Coffee Roasting Chemistry

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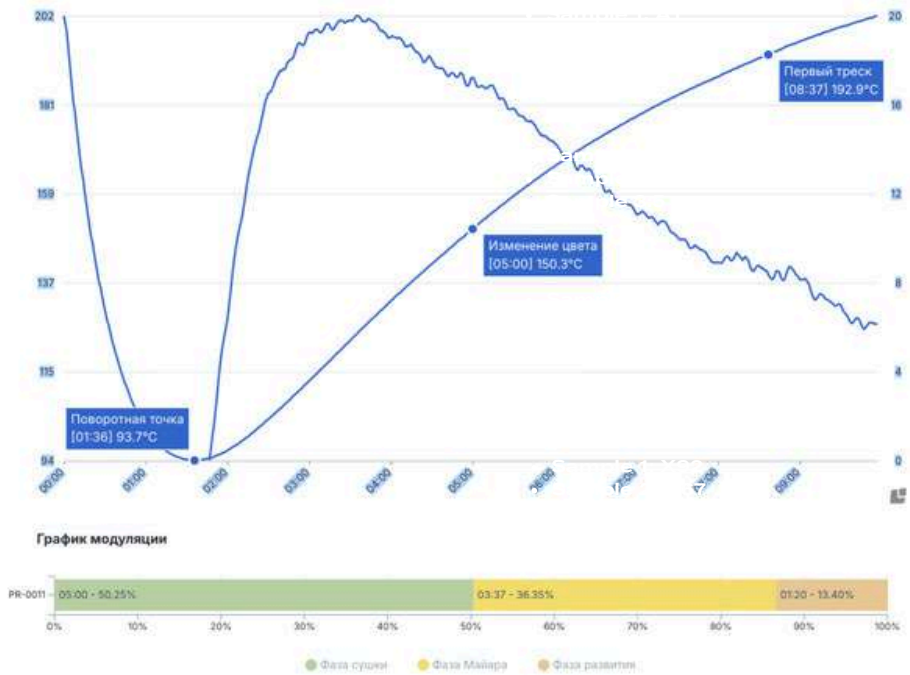
STAGES OF COFFEE ROASTING

1. Loading
2. Turning point
3. Stage 1 - green
4. Stage 2 - yellow
5. First crack
6. Development
7. Drop



MAILLARD REACTION

– is a chemical process that occurs when amino acids and sugars are heated. When coffee is roasted, the Maillard reaction creates new flavor and aroma compounds that give beans its color and develop aromas. The reaction requires a certain amount of energy and time, and it is very important to understand this mechanism.

WHAT'S HAPPENING?

- At temperatures around 130-160°C, sugars and amino acids begin to react. This process results in the formation of melanoidins, dark pigments that give the bean its color and develop aromas such as nuts, caramel, bread, and possibly malt.

- The longer the Maillard reaction lasts, the richer and deeper the descriptors that are formed.

Effect on Taste: The Maillard reaction creates the basis for a coffee's flavor profile and body texture nutty, bready, and chocolatey notes.

How to use: The duration of the Maillard reaction directly affects the final profile. The longer the reaction, the more melanoidins are formed, which can change the taste and aroma of the coffee.

CARAMELIZATION OF SUGAR

– an important process that affects the taste of coffee. At high temperatures, the sugars in beans caramelize, which gives the coffee its sweetness and complexity of taste. The level of caramelizing is measured with a calorimeter, it is a quantitative value.

WHAT'S HAPPENING?

- Sugars in beans, such as glucose and fructose, begin to break down and transform into more complex compounds that create sweet, caramel, and sometimes even fruity notes.
- The caramelization process requires precise temperature control. If the temperature is too high, the sugars may burn, and instead of sweetness, we get bitterness.

Effect on taste: Caramelization adds sweetness to coffee. But it is important to understand that caramelization leads to bitterness.

How to use: Time and intensity (modulation) of roasting affect the level of caramelizing process.

STRECKER DEGRADATION

refers to chemical reactions that occur at high temperatures. This process affects the taste and aroma of coffee, especially in the later stages of roasting.

WHAT'S HAPPENING?

- During coffee roasting, chemical reactions occur that lead to the formation of new flavor and aroma compounds, including Strecker's degradation.
- The concentration of Strecker degradation in coffee depends on the degree of roasting: there are more of them in light or medium roasted coffee, since they do not have time to break down.

Effect on flavor: Strecker degradation can impart fruity, floral, and nutty flavors and aromas to coffee.

How to use: Adjust the roasting speed. Fast roasting at high temperatures produces more aldehydes, but can also introduce other undesirable flavors.

CHEMICAL REACTIONS IN COFFEE

REACTION	WHAT DOES IT GIVE?	WHAT IS NEEDED	WHAT REACTS	WHEN IT STARTS
Caramelization	Sweetness, then bitterness, color change	Time and temperature	Sugars (fructose, glucose, sucrose and others)	110-190°C
Maillard reaction	"Coffee flavors", melanoidins (color, creams)	Time and temperature	Carbohydrates, proteins	130°C
Strecker degradation	Aldehydes (aroma, fruitiness)	Maillard reaction products, time, temperature	Amino acids	160°C

2. PREPARATION FOR ROASTING

2.6 Roasting Philosophy

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FORMATION OF ASSORTMENT

TARGET AUDIENCE

- It is important to decide what and for whom to roast: gender, age, income, habits and other characteristics.

TARGET AUDIENCE SEGMENT

- The more accurately you define your audience, the clearer the rest of the processes will be.

ROASTING STYLE

- Based on your taste or the preferences of your clients, American, Italian, Scandinavian.

EQUIPMENT FEATURES

- Load size, air or conduction.

WHOLESALE/RETAIL

- This will influence the selection of varieties and the number of blends.

PRICING

- The most important aspect when working with clients is the formation and development of a brand.

BLENDS AND SINGLE ORIGIN

	PROS	CONS
Single origin	Unique bouquet Attracts attention Wide range of taste	Instability of harvesting (seasonality) More difficult to work with (for roasters and baristas)
Blends	Stability Balance of taste Flexibility of composition	Simpler bouquet Less attraction of attention

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ROASTING STYLES

STYLE	BALANCE	BOUQUET	BODY	SEGMENT	PECULIARITIES
Scandinavian	Towards acidity and brightness	Well expressed fruitiness, varietal characteristics and bright descriptors	Light	New wave, specialty coffee, coffee geeks	Suitable for "expensive" and unique, not suitable for commercial beans
Italian	Towards bitterness	Low grade, high bitterness, chocolate, carmelization group	Full	For the old school	Hides the uniqueness of the coffee bouquet, more suitable for medium and commercial beans
American	Balance of bitterness and acidity	The caramelization group is expressed, the acidity is noticeable.	Average, above average	Mass, wide	A versatile, easy to understand roasting style