Coffee Roasting Optimization Focusing On Afterburner Performance and Energy Saving
- **Company Name:** Gas Brasiliano Distribuidora  
  Natural Gas Distributor in Brazil

- **My Job:** Marketing and Customer Support

- Coffee Roasting
- Process Optimization
PRODUCERS AND CONSUMERS OF COFFEE IN THE WORLD

TOP 5 - PRODUCERS

1. Brazil
2. Vietnam
3. Indonesia
4. Colombia
5. Ethiopia

TOP 5 - PER CAPITA CONSUMERS

1. Netherlands
2. Finland
3. Sweden
4. Denmark
5. Germany

Source: Brazilian Coffee Association
WHAT IS COFFEE ROASTING?

- Roasting is a heat process that brings out the aroma and flavor that is locked inside the green coffee beans.

- There are hundreds of flavors and aromas that can be extracted from the coffee bean, depending on the temperature and the time the bean is exposed to the hot air flow.
3 PHASES:

- **Drying phase**: which aims to eliminate moisture inside the bean.

- **Pyrolysis phase**: when coffee beans develop their specific aromas and flavors.

- **Cooling phase**: when water is sprayed on the beans, interrupting the temperature increase, in order to reach the desired degree of roasting.
OBJECTIVE: This technical research aims to publicize the details of the coffee roasting process, highlighting the afterburner stage.

MOTIVATION:
- Nearly 70% of heat input to the roaster leaves through the chimney;
- The lack of information on how optimize the energy usage in coffee roasters in my country.
METHODOLOGY:

- Consultation with manufacturers of coffee roasting equipment and their advice for energy saving measures.

- Case study - implementation of energy saving measures whenever possible or calculate the potential gains.

- Creation of an energy saving rank.
AFTERBURNER OPTIMIZATION – MEASURE 1

The afterburner uses more energy than the roasting process itself:

60% 40%

There are two afterburner options:

A-) Thermal - VOC destruction at 700°C
B-) Catalytic - VOC destruction at 400°C

Catalytic afterburner implementation:

- More costly solution
- Expectation of catalyst replacement: every 3 years

Catalytic converter with chemical reaction.

25% ENERGY CAN BE SAVED
AFTERBURNER OPTIMIZATION – MEASURE 2

In order to optimize the afterburner operation, we can reduce the power when the VOC emissions are low.

- Beans released VOC only at temperatures above 225°C.

- Coffee producers in Brazil do not know this and keep the afterburner working full batch.

In order to optimize the afterburner operation, we can reduce the power when the VOC emissions are low.

✓ 20% ENERGY CAN BE SAVED
A thicker or high quality insulation can reduce the heat radiation from the roasting system to the environment.

Replaced the furnace and ducting insulation

✓ 4% ENERGY CAN BE SAVED
- Configuration A: Should be avoided

- Configuration B: Recycling the exhaust gases while VOC emissions are low.

Lesser energy loss caused by exhaust gas heat.

✔ 30% ENERGY CAN BE SAVED
Bean temperature depends on:

- Hot air flow
- Hot air pressure

The flap damper plays crucial role in controlling the roasting parameters.

Flap damper replacement:

- The previous flap damper: 2 positions
- The new flap damper: 4 positions

✓ 7% ENERGY CAN BE SAVED
Drying phase is a less time-sensitive phase.

Increasing the hot air pressure in the drum during this phase, accelerate the time of water evaporation.

Significant reduction of batch roasting time.

3% ENERGY CAN BE SAVED
EXPLOIT THE ENERGY OF THE EXHAUST GASES BY USING THEM TO PRE-HEAT THE INCOMING PROCESS AIR: FRESH AIR OR COMBUSTION AIR.

### Installation of the Heat Exchanger

- **30% Energy can be saved**
- **7% Energy can be saved**

**Pre-heating fresh air**

*(process cycle)*

**Pre-heating primary combustion air**

*(up to 250°C)*

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**GasBrasiliano**
Exploit the energy of the exhaust gases by using them to pre-heat the green coffee bean before dropping them into drum.

Using cleaned exhaust gases from roaster

Add a mixing chamber

✓ 15% ENERGY CAN BE SAVED
- In most cases, the incineration of VOC (volatile organic compounds) and odor in the afterburner result in an excessive use of energy.

- Some energy saving measures are available and must be studied in terms of technical and economic feasibility for each case.

<table>
<thead>
<tr>
<th>Measure</th>
<th>Energy Saving</th>
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<tbody>
<tr>
<td>Pre-heat the incoming fresh air (process air).</td>
<td>30%</td>
</tr>
<tr>
<td>Exhaust gas recirculation.</td>
<td>30%</td>
</tr>
<tr>
<td>Catalytic afterburning instead of thermic afterburning.</td>
<td>25%</td>
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<tr>
<td>Reduce burner power when VOC levels are acceptably low.</td>
<td>20%</td>
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<tr>
<td>Pre-heat green coffee bean before dropping them into the drum.</td>
<td>15%</td>
</tr>
<tr>
<td>Pre-heat primary air combustion.</td>
<td>7%</td>
</tr>
<tr>
<td>Optimization of roasting parameters (trials).</td>
<td>7%</td>
</tr>
<tr>
<td>Improvement of insulation quality.</td>
<td>4%</td>
</tr>
<tr>
<td>Provide greater hot air pressure in the chamber at drying phase (Reduction of batch time).</td>
<td>3%</td>
</tr>
</tbody>
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THANK YOU

FOR YOUR ATTENTION !!