**2. DESIGN REQUIREMENTS/CONSTRAINTS**

**2.1 Technical Design Constraints**

Table 2.1 contains the five technical design constraints that must be adhered to upon completion of this product.

**Table 2.1 Technical Design Constraints**

|  |  |
| --- | --- |
| **Name** | **Description** |
| Power Draw | IntelliRoast must draw under 15A at 120V to comply with NEC standards for kitchen circuit current limits [1]. |
| Roasting Temperature | The heating element must heat the roasting chamber to 300°C. |
| Surface Temperature | IntelliRoast must comply with ASTM C1055 standards to protect the user from irreversible injuries [2]. The device’s exterior enclosure must not exceed 60°C. |
| Bean Agitation | IntelliRoast’s fan must lift ~120g of beans to agitate during roasting and eject from chamber after roast is finished. |
| Wireless Distance | The user’s smartphone must connect to IntelliRoast from a maximum distance of 3 meters. |

**2.1.1 Power Draw**

IntelliRoast must not exceed 15 amps, the average current draw for kitchen appliances. The National Electrical Code (NEC) specifies that the average kitchen should have at minimum 2 circuits rated for 20 amps at 120 VAC [1]. The general practice for current rating is that the continuous draw should not exceed 80 percent of the rated capacity. At 20 amps, the continuous current draw rating equals 16 amps. IntelliRoast’s constraint of 15 amps adheres to NEC specifications and still operates within homes which do not meet this specification.

**2.1.2 Roasting Temperature**

IntelliRoast must sustain an ambient temperature of 300°C within the roasting chamber. Depending on the roast level, the process of roasting coffee requires the beans to reach an internal temperature of 205°C-250°C [3]. This target temperature will roast the beans within the target timeframe of 10-12 minutes.

**2.1.2 Surface Temperature**

IntelliRoast’s exterior enclosure must not exceed a surface temperature of 60°C. Temperatures exceeding this peak can present a burn risk for the user. ASTM C1055 standards specify for the surface temperature of 70°C as the upper limit for safe operation. IntelliRoast’s constraint of 60°C adheres to ASTM standards and further reduces first-degree burn risk.

**2.1.4 Bean Agitation**

IntelliRoast’s fan must lift and agitate 120 grams of beans during roasting and eject them from the chamber after the roasting process is finished. If the beans are not mixed and agitated during the roasting process, they will roast unevenly. The beans at the bottom of the chamber could char while others may not roast. In order to simplify the mechanical design, the beans will share a single entrance and exit from the chamber.

**2.1.5 Wireless Distance**

IntelliRoast must communicate wirelessly between the device and the user’s smartphone at a distance of 3 meters or less. While 1 meter will suffice for personal use, 3 meters will allow the user to tend to other tasks as needed.

**2.2 Practical Design Constraints**

The product must also adhere to the five practical constraints listed in Table 2.2

**Table 2.2 Practical Design Constraints**

|  |  |  |
| --- | --- | --- |
| **Type** | **Name** | **Description** |
| Environmental | Water Resistance | IntelliRoast must comply with IP53 standards to protect from water sprays less than 60 degrees from the vertical and protect against entry of dust in sufficient quantity to interfere with satisfactory operation of equipment [4]. |
| Economic | Cost | In order to compete on the open market, IntelliRoast should cost roughly less than $500 due to part costs and retail markup. |
| Sustainability | Hands Free Usage | IntelliRoast should operate without user intervention. |
| Social | App-Enabled | IntelliRoast must connect to a smartphone app to utilize additional features. |
| Safety | Chaff Collection | IntelliRoast must have the ability to collect chaff to avoid potential fire hazards. |

**2.2.1 Environmental**

IntelliRoast must comply with IP53 ingress standards. IntelliRoast’s main operating environment will contain hazards such as foreign objects and liquids. According to the International Protection Marking (IP), IP standards call for “protection of persons against access to hazardous parts, and protection of equipment against ingress of solid foreign objects” and “protection of equipment against harmful ingress of water” [4]. IntelliRoast’s IP53 rating will protect the equipment from entry of dust and water sprays approaching from less than 60 degrees with respect to the vertical.

**2.2.2 Economic**

IntelliRoast’s current parts constraints and retail markup must cost less than $500. IntelliRoast is competing against home coffee roasters costing upwards of $1600 [5]. This significant cost difference makes IntelliRoast a viable competitor in the current coffee roasting market. Even though the production cost of IntelliRoast is lower than its competitors, the price is set primarily through the electronics and necessary heating element.

**2.2.3 Sustainability**

IntelliRoast’s process of roasting must be fully automated. The preparation of the roast is designed to be an intimate and customizable user experience, and after initiating the roast, the process is entirely hands-off. Internally, IntelliRoast must heat up its heating coil, monitor bean temperature, and adjust the airflow and chamber temperature based on the roasting profile without user influence or any outside assistance. Traditional hand roasting is a physically demanding process yielding inexact and non-reproducible results. The automation of these key steps will ensure the exact roast profile is easily and quickly repeatable.

**2.2.4 Social**

IntelliRoast’s companion phone app must allow the user to select and customize their roast profiles, start the roasting process, and view other important information about the roast. The app must have an easy-to-use interface requiring no prior training.

**2.2.5 Safety**

IntelliRoast must collect the chaff in a container for disposal. Chaff, a paper-like substance, flakes off coffee beans during the roasting process. If not properly collected and disposed, chaff can create a fire hazard. IntelliRoast will keep all chaff away from heating elements in order to avoid the potential of chaff catching on fire. Even with this potential fire hazard, IntelliRoast will not have any openings for the chaff to go near the heating element.

**References**

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