The Science of Roasting Coffee
An Overview
Presented by The Heritage Coffee Co. Ltd.
Revised June 6, 2012.

The coffee roasting process in general terms involves the application of heat to green-coffee which transforms the raw (green) beans through pyrolysis to the roasted state. In the green state, the coffee is mostly inert (does not react with its environment, most notably the oxygen in the atmosphere) and does not yield the capability to have the soluble oils readily extracted under traditional coffee brewing technology. Roasted, the molecular change in state allows for this extraction, but also renders the soluble oils volatile making them susceptible to degradation in quality when exposed to air. This transformation using pyrolysis is therefore critical in the flavour development and consistency of the coffee when properly prepared in the brewed state. In other words, the proper roasting of the coffee is critical to the consistent quality of the final product.

To achieve a consistent roast several aspects of the process must be addressed:

The roasting equipment and its process
The human interaction with the equipment
The evaluation of the final product
The packaging of the final product

The Roasting Equipment and its Process

The essential element of all effective roasting equipment is repeatability. Roasters need to be designed to be able to consistently repeat the same results time after time. Heritage uses 3 different types of roasters to achieve these results, all of them industrial in scope as well as completely controllable in function. The three types (different sizes for production flexibility) all are capable of roast profiling as well as modulation which provides flexibility in the roasting process.

After the green coffee has been charged into the roaster, the rotating drum within the roaster will keep the beans in motion to ensure an even roast on all beans. The roast profile is set for the blend in use and the intensity of the heat is modulated over the different stages of roast development. A thermal probe monitors the temperature of the beans (not the roaster, the beans temperature is a more precise determinant to roast development) and is monitored by the operator. By using this method of roasting, the uniformity of roast from the inside of the bean to the outside of the bean will be synchronistic. Coffee that is roasted too quickly or with too great a variance on modulation will yield too great a difference of roast degree from the whole bean product to the ground product. Once the final stages of development have been achieved (specific to the desired roast per product specification), the roaster prepares for the quench sequence of the process.

The Quench

Roasted coffee beans store energy in the form of heat within the bean. This heat has a degree of thermal inertia which will continue to roast the coffee even after the heat source in the roaster has been stopped. The result is that the coffee will go beyond the roast profile desired rendering the coffee unusable for its intended application. To overcome this phenomenon, water in the form of a fine mist is introduced to the coffee in the roaster to rapidly reduce the temperature of the coffee and arrest the roasting process. Essentially, there is a thermal dynamic reaction that follows the laws of entropy which draws the heat rapidly away from the bean into the water and then manifests itself in the form of steam. The amount of water used is critical to the integrity of the coffee as using too much will re-introduce moisture into the coffee leaving it prone to premature staling while too little will not effectively arrest the roast. Once the water quench is completed, the beans are discharged from the roaster into an apparatus which will air cool the beans using great volumes of air and agitation to evenly cool the beans further.

Triage

After the beans have been sufficiently air cooled, they go through a pneumatic triage process which elevates the beans using reverse air pressure that is designed to draw mass specific to the density of coffee beans; all other heavier densities fall into the rejection tray.

The Evaluation of the Final Product

After each roast, every batch of coffee is tested in the laboratory to ensure the product falls within the specified parameters. An Agtron E20 is used to quantify roast degree. Employing near infrared technology, the Agtron will measure the signature frequency of quinic acid (a naturally occurring organic compound found in roasted coffee) in the roast sample which is quantifiable on an inverse proportional basis. Further, moisture analysis as well as organoleptic testing is done to ensure the quality of the coffee is congruent with the specifications.