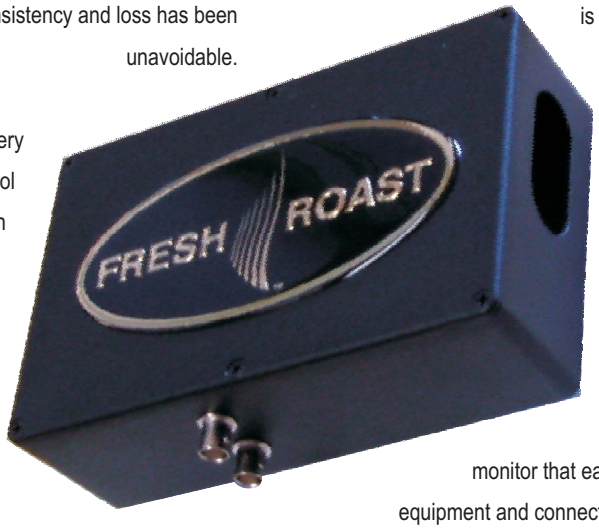
ColorTrack®

Fresh Roast Systems, Inc. proudly introduces **ColorTrack.** **ColorTrack** represents the most significant advance in coffee roast control since computer controlled profiling. Roastmasters have traditionally been totally dependent on monitoring time, temperature and color. Time and temperature can be computer monitored and controlled yet color assessment is still totally dependent on the eye of the roastmaster and for various reasons often subject to human error. With the ever-changing characteristics of crop freshness, variances in the roasting environment and potential for error relative to subtle and quick changes in roast development, inconsistency and loss has been unavoidable.



ColorTrack takes charge of one very important part of the processing control by providing an innovative solution offering unparalleled precision before and during roasting. The end result is an unmatched level of quality and consistency. **ColorTrack** uses a patented laser system to analyze color development throughout the roasting process and alerts you to the actual color development at termination of your existing roast profile. When time and temperature control fails to yield the best results, **ColorTrack** can control the degree of roast development and stop the roast at the precise point when the desired color has been reached. **ColorTrack** closes the gap on even the most subtle differences in roasting variables making your finished product the best match to your process standard. With **ColorTrack** you get perfect, identical results every time and absolute repeatability whether roasting in Tokyo or Topeka. All your roasting sites will match regardless of local conditions.

One of the most significant problems in commercial roasting is product shrinkage due to time and temperature error. **ColorTrack** eliminates these losses entirely. There is never waste, loss or the additional cost of labor associated with reworking either. The roast is perfect every time regardless of the profile. Whether your operating a global plant operation or a simple shop roaster, savings will be significant. Loss prevention is a given. Product consistency is the bonus and **ColorTrack** delivers, guaranteed.

ColorTrack is available as two different tools. The real-time roast monitor that easily mounts to any existing roasting equipment and connects to your computer profiler via USB connection. **ColorTrack** is also available in a stand-alone bench version for use in your coffee lab to help determine drop points and preferred roast profiles. Call to get more information on **ColorTrack** and the basic tools no roasting operation should be without. Make your coffee the best and most consistent it can be.

FRESH ROAST

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A Division of Group 32 Development & Engineering, Inc.

Coffee Roasting and Color

Coffee roasting is both a physical and chemical process. Physically we see the coffee beans change color, swell in size and become less dense as they lose about twenty percent in weight.

Simultaneously, there is a change in molecular chemistry that creates the aromas and flavor constituents we so appreciate in the cup.

The reason there is such great variation in coffee flavors is because we are dealing with a seasonal commodity that has an astounding number of molecular compounds more than any other food or beverage and a heating process that directly contributes to the final flavor, more than any other cooking method.

The flavor of a coffee is determined by the natural potential that is in the beans and shaped by the way it is roasted. Green coffee traders have long been aware that all beans are not created equal. The best high-grade coffees are rare and much sought after. Consequently they are more costly.

Regarding the roasting; simply put, it is a time-temperature process that would be more straightforward if we were just baking a cake. A cake requires pre-heating the oven and baking for a prescribed length of time at a particular temperature. We can estimate when it's ready after we check to see if it's cooked throughout. Coffee, on the other hand, is roasted to color. Without instrumentation to assess the color it must be roasted by eye or to a particular temperature or for a determined amount of time.

The coffee roasting process is far more complicated than baking. Yet like baking you can bake fast or slow. Normal roasting is based on the time it takes for the beans to absorb the heat evenly throughout the beans. A gentle approach produces a normal roast with expected results. Although is not uncommon to roast about twenty percent faster or slower to produce variation in the taste of the coffee.

Say a standard roast takes twelve minutes for a standard taste. A faster roast of maybe ten minutes would give a brighter and cleaner taste to the coffee. Such a coffee is better for drip brewers. A slower roast of about fourteen minutes is better for espresso because it will likely give a smoother and heavier taste to the cup. This fine-tuning can be accomplished by controlling the heat and airflow during roasting.

Roasting is necessarily complex in its chemistry. This is because the myriad of natural compounds found in coffee beans is considerably altered in the roasting process. As coffee beans heat up, certain complex compounds breakdown and are degraded into simpler compounds, which in turn will re-combine into other compounds creating the variation in the flavor and aroma components of the finished product.

The rate of heating the beans is but one of the ways the taste of a coffee can be manipulated. The pre-heat temperature, rate of increasing the temperature and alterations in the airflow can all have an effect on the final taste. A roastmaster will select the control parameters of time and temperature, which determines the profile of the roast.

All commercial roasting machines manufactured today are equipped with a computer controller that allows the operator to pre-select and control the heat and airflow throughout the roasting process. Some are able to track previous time/temperature profiles in order to duplicate previous roasts. Unfortunately all these systems only work on duplicating time and temperature routines whereas Fresh Roast Systems actually tracks the color development that encompasses all other variables.

If all coffees were the same a time/temp profile would suffice for producing consistency. Unfortunately this is not the case, so we roast to bean color which is a much more dependable approach to consistency in flavor.

There are several other factors that affect how a coffee roasts; moisture content, bean size, density and freshness. Some flavor notes are determined by the elevation at which the coffee is grown as well as climate conditions and soil composition. You have probably heard the promotions touting the merits of Mountain Grown and Volcanic Soil.

The Country of Origin makes a major contribution to the flavor of a coffee. A Sumatran coffee will taste dramatically different from a Colombian or Ethiopian. Experience has taught us that a Sumatran generally tastes better at a dark roast, Colombian at a light roast and Ethiopian usually at a medium roast.

We do not know in advance exactly what temperature will yield the desired degree of roast for each coffee. This is why a Color Track Laser system is used on Fresh Roast Machines to electronically read the developing roast color throughout the process and stop the roast automatically at the desired degree of roast regardless the temperature.

Color is consistency.

Coffee Color Measurement and Roast Classification

By Robert Barker, Published June 2008

“No one has ever presented a technique for the measurement of roasted coffee color that could be considered for adoption as a standard for use throughout the coffee industry. No one has ever suggested a standard list of names for different colors of roast. Nor has anyone tried to associate a useful list of names with color values derived from a modern method of measurement.” E.E Lockhart, May 25, 1960, San Francisco, California. *

In the late 1950s a team of researchers from the Department of Food Science and Technology at the University of California in Berkeley published a series of papers on the a scientific approach to the color of coffee, it measurement and its relationship to flavor. Four of these papers were published in the Journal of Food Technology and presentations were given at the annual meetings of the Institute of Food Technologists in Chicago, Philadelphia and San Francisco.

At that time in 1958, Dr. E.E. Lockhart, with the Coffee Brewing Institute in New York was writing a publication entitled The Analysis of Coffee Grinds. Dr. Lockhart collaborated with the Berkeley scientists and closely followed their results. In 1960 he was citing their work and in 1967 he reprinted their research papers as Publication Numbers 17, 37, 48 and 51 of the Coffee Brewing Center. In March of 1960, one of the Berkeley scientists, Angela Little, contributed an article to The Tea and Coffee Trade Journal entitled “Collaborative Study of the Measurement of Color of Ground Coffee” thus bringing the subject to the attention of coffee industry as a whole. This new research contributed an important milestone in coffee science.

Coincidently, in 1960, Gordon Gould and Thomas Maiman independently invented the first Lasers. It would take almost fifty years to pass, before a laser would be applied to reading the color of roasted coffee but we will get back to this subject later in this article.

For the one thousand years that people have been roasting coffee, they have relied on a variety of sensory clues to determine when to end and stop the roasting process. Consistency and quality are determined by accurately stopping the roast at exactly the right time.

From the earliest days of coffee roasting we determined coffee roast development by eye, noting the visual assessment of color and the swelling of the coffee beans. There is a cracking sound that roasting coffee gives us for audible clues. Aroma development signals the point of pyrolysis and the oil formation on the bean surface and the subsequent smoke emissions also alert us to timing for terminating a roast.

Often a number of these sensory inputs are used in tandem or simultaneously to monitor the roasting process. These visual references and other sensory clues have been used for the last millennia since Bedouin began roasting in small open pans during encampments. All around the world people have roasted by eye whether in clay bowls or stove top pans.

Most modern sample roasters still encourage us to roast by eye as we pull trier sample after

sample for color scrutiny.

It is still commonplace for a roastmaster to frantically pull samples as he nears the end point of his roast. The color changes are much more rapid as the roast progresses to ebony. There are obvious pitfalls in this subjective method. Individual differences in color perception, lighting, operator fatigue and interpretation of the descriptive terms such as light, medium, and medium dark, French etc.

There is a class of “artisan roasters” who swear by the two audible crack or popping sounds coffee makes as the beans reach a point of stress responding to internal gas pressure and secondly, the point of cellular structure degradation due to charring within the beans. These points are enthusiastically referred to as the “first crack” and “second crack” and are commonly used to monitor and determine when to end the roast.

Aroma development is another clue to roast development progress, especially for those who roast on sample roasters or roast outdoors. The smell of coffee changes considerably as chlorophyll is degraded, sugars caramelize and oils vaporize.

Our dark roast aficionados may also rely on the appearance of surface oils and the blue smoke that rises out of the pyre before they're ready to call it quits.

All these points of reference are helpful in the attempt to craft consistency where instrumentation is not available. When commercial roasting machine manufacturers began adding thermometers to their effluent gas pipe, mainly to measure pre-heating temperatures, it was an obvious next step to put a thermometer through the faceplate of the roaster to measure the roasting bean's temperature directly.

Today most roasters have thermocouples in the bean mass (bean temperature probes), which allows monitoring of the roast progress and thus giving us notification as to when the end point temperature is reached. Larger roasting machines will automatically water quench at the end point temperature and smaller machines without quench, may automatically turn on the cooling tray fan, start the sweep arm and by use of servo control, open the drum door to drop the roasted coffee into the cooling tray. Temperature control is good.

For the professionals and sophisticates there are more complex programs being used such as stepped roasting, ramp roasting and profile roasting. The later requires computer control of the input roast gasses relative to the bean temperature.

Computer controlled roasting machines generally arrest the roast at a designated end point temperature that is monitored by either thermocouples or infrared sensors. Water quenching arrests a roast immediately. Without water quench the coffee will still continue to roast somewhat until the cooler has had sufficient time to have an effect on the internal bean temperature.

Regardless of the drop temperature, Color has always been the gauge of roast development. We have a litany of roast terms from “Cinnamon” for the lightest roast to “French and Italian” to describe our darkest roasts.

Insert tables

Color is what most consumers use to make a decision when purchasing whole bean roasted coffee. Telling a customer that his coffee was roasted to 465 degrees F. means nothing to the average consumer. Referring to it as a Full City roast is more common, yet just as vague. Eventually the consumer makes the connection with local roast names and their favorite flavor characteristics, particularly if they grind their own coffee at home. They begin to appreciate the dry aroma or “bouquet” of the ground coffee, its color and its relationship to taste.

Color is the roasters basic descriptor of his coffees. In order to monitor color and scientifically define color, a number of roast analyzers have been used by the industry over the last fifty years, Electronic measurement of roast color is best accomplished by instruments that take reflectance measurements.

In the 1960s, Dr. Lockhart et al. experimented with half a dozen devices and settled on the Photo-Volt brand reflection meter as the most user-friendly for coffee roasters. Also included in their overview of the study is a recommended eleven point descriptive scale derived for roast color values from extremely light, medium to extremely dark.

Insert Lockhart table

Brown colors are very difficult to accurately discern with the unaided eye. There are, in fact, several pitfalls in the subjective method. Poor lighting, coupled with the bean's matt finish contributes to the problem. To complicate the matter more, color perception is unique to the individual; we all do not have the same recognition of colors, particularly those so subtle as shades of brown. In addition there is variety in interpretation of the descriptive terms such as light, medium, full city, French, and not to forget, operator fatigue.

In the last several decades have seen many color reading devices introduced to the food industry, principally for quality control for purposes post production. Today, even paint stores and interior decorators use them,

In recent years the Agtron and Probat Colorette have come into common use. Surprisingly the laser, which was invented in 1960, where our story began, has only recently been applied to reading roasting and roasted coffee color. With such an instrument affixed to the front of a roaster it is possible to read and record the coffee color throughout the roasting process.

Color Track text

Fresh Roast Systems, of Palo Alto California, is the first company to patent and introduce this most significant advance in coffee roast control since computer controlled profiling. Time and temperature has been computer monitored and controlled for some time yet color assessment, until recently, has been totally dependent on the eye of the roastmaster and if it came out wrong it was noticed only after the mistake is made, often much later by the quality control department. With the ever-changing vagaries in crop freshness, variances in the roasting environment and potential for error relative to subtle and quick changes in roast development, problems of inconsistency and loss has been unavoidable.

Now the laser system can be used to analyze color development throughout the roasting process and alert you to the actual color development at termination of your existing roast profile. Laser monitoring closes the gap on even the most subtle differences in roasting variables making your finished product the best match to your process standard. With it you get perfect, identical results every time and absolute repeatability whether roasting in the US or abroad. All roasting sites will match regardless of local conditions.

One significant problem in commercial roasting is product wastage due to time and temperature errors. On line roast color analysis eliminates these losses entirely. There is never product loss or the additional cost of labor associated with reworking. The roast is perfect every time regardless of the profile.

The Color Track laser is available as two different tools. The real-time roast monitor that easily mounts to any existing roasting equipment and connects to your computer profiler via USB connection. It is also available in a stand-alone bench version for use in your coffee lab to help determine drop points and preferred roast profiles.

With the real-time instrument the laser beam is focused through a viewing port (sight glass) on the faceplate of the roaster and directly reads the color of the beans as they are roasting. The laser is not affected by the bean temperature so the readings are linear. The laser data is fed to the computer controlling the roasting machine functions, making it possible to initiate changes in control settings during the roast and to stop the roast at any pre-set color related degree of roast.

By recalling and overlaying the plot of time vs. temperature with the plot of color development, the operator can see the color of the beans in relationship to any control changes throughout the roast profile. He can see where color changes slowly and where it speeds up. He can see the color at the first crack and correlate all other aspects of the roast with reference points of time, temperature and color.

The laboratory bench unit works in concert with the machine laser. The bench unit is uses the same laser with the same calibration to measure whole bean color and the ground coffee color. The difference between these two colors is significant to the roasting process and resulting flavor characteristics of the coffee. Difference in whole bean color and the ground color is referred to as “delta”. It reveals the beans heat absorption characteristics just as the pink in a steak relates to medium rare.

Calibration matching of the bench unit with the roaster unit makes it possible to fine-tune roasting profiles through traditional cupping procedures. A roasted sample from any source (your own in house, that from another facility or from a competitor) can be read and the resulting data can be input to your roaster controller so that it can duplicate the roast color with any coffee.

Roast color deltas between whole bean and ground coffee can be accurately determined because the laser is not as sensitive to sample preparation as some systems. Roast differences in cut-off color and drift due to the cooling process can also be easily measured and accommodated.

Finally we have caught up to the sixties. No wide paisley ties please.

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"Roasted Coffee, Color Measurement and Classification"
Presented at the Twentieth Annual Meeting of the Institute of Food Technologists,
By Dr. Ernest E Lockhart,
The Coffee Brewing Institute, Inc.
New York 5, N.Y

Robert Barker is a member of The Coffee Review Cupping Board. A distinguished group of specialty coffee industry leaders and experienced cuppers assembled by the Coffee Review to assist in reviewing coffees. He is an industry expert and currently a consulting technician to the Coffee Review, as well as a green coffee buyer for Keystone Coffee in San Jose, California and an organic coffee producer in San Agustin, Colombia.