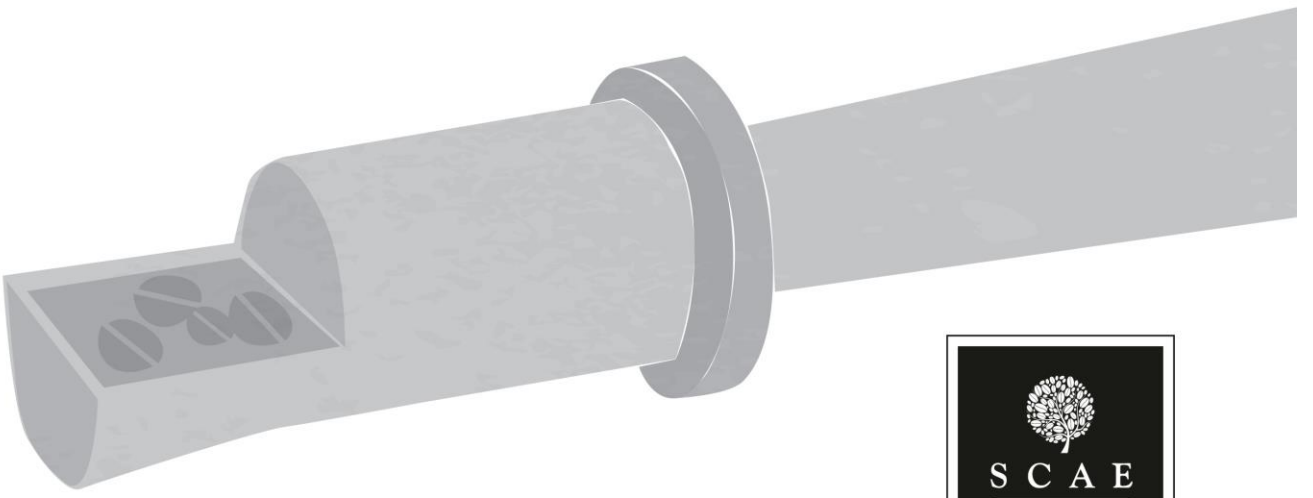
ROASTING

Roasting



SCAE
COFFEE
DIPLOMA

OVERVIEW: Designed to introduce the **INTERMEDIATE** into the core skills for identifying roast profiles and defects. Students are introduced to different chemical conditions and principles that cause the physical properties and reactions introduced at foundation level. Courses detailing the information required to attempt the qualification are expected to last 2 days. The pass mark is 70%.

Roasting Intermediate

Pre-requisites for participation in the Intermediate certification process:

- Roasting Foundation
- Sensory Foundation
- Green Coffee Foundation

Blooms Taxonomy for Intermediate Level

Level 3: Application – Use information in a new way				
Translate	Illustrate	Sketch	Sequence	Prepare
Interpret	Operate	Employ	Carry	Generalize
Apply	Demonstrate	Schedule	Out	Repair
Practice	Dramatize	Use	Solve	Explain
Level 4: Analysis – Distinguish the different parts				
Distinguish	Contrast	Relate	Classify	Catalogue
Differentiate	Calculate	Experiment	Discover	Investigate
Appraise	Criticize	Estimate	Discriminate	Breakdown
Analyze	Examine	Observe	Identify	Order
Compare	Test	Detect	Explore	Recognize
Determine				

SUB CODE	KNOWLEDGE/SKILL REQUIRED	STANDARDS	REFERENCE
1.0 HEAT TRANSFER			
1.01.01	Heat is thermal energy inside a material Heat always goes from hot to cold materials Heat can be transferred by different 'types' of heat transfer methods and different methods affect the beans differently		Wiki: Heat Wiki: Heat_transfer (Jansen 2006; Huschke 2007) p. 27ff (Huschke 2007; Illy & Viani 2005) p. 184ff (Belitz et al. 2009; Jansen 2006) p. 17f (Huschke 2007; Illy & Viani 2005) p. 183f (Clarke & Vitzthum 2001; Toci et al. 2009)
1.01.02	Control the heat source in a coffee roaster		Wiki: Heat Wiki: Heat_transfer (Jansen 2006; Huschke 2007) p. 27ff (Huschke 2007; Illy & Viani 2005) p. 184ff (Belitz et al. 2009; Jansen 2006) p. 17f (Huschke 2007; Illy & Viani 2005) p. 183f (Clarke & Vitzthum 2001; Toci et al. 2009)
1.02.01	**CONDUCTION/CONTACT** Conduction is when materials touch each other and the heat diffuses from the hotter to the cooler body Once the heat reaches the surface of the bean it is transferred inside bean, by diffusing from the hotter surface to the colder centre, which could lead to colour gradient inside bean	L3	(Belitz et al. 2009; Clarke & Vitzthum 2001) p. 98-99 (Illy & Viani 2005) p. 183-184
1.02.02	Identify burned spots on coffee as marks of aggressive contact heat transfer	L3	(Belitz et al. 2009; Clarke & Vitzthum 2001) p. 98-99 (Illy & Viani 2005) p. 183-184
1.03.01	**CONVECTION** Convection is thermal energy transfer by means of hot air. It is a special kind of contact heat transfer since heat is transferred when the hot air touch/is in contact with the colder bean. The magnitude of temperature difference between then air between the beans and the beans themselves is the magnitude of convection heat transfer at any given stage of the roast	L4	
1.03.02	Analyse a roast profile for the level of 'convection' in different stages of the roast (temperature difference between air and bean) and be able to adjust this to design a roast profile	L4	

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1.04.01	**RADIATION** Radiation is electromagnetic rays that naturally is emitted from a heat source and converted into thermal energy in the material it reaches. Radiation is not completely converted into thermal energy at the surface of the bean, but there is an absorption gradient in the bean so some heat is added inside the bean without affecting the surface	L4	
2.0 BASIC ROASTING AND THE ROASTING CYCLE			
2.01.01	Evaporation takes heat energy to proceed. Pyrolysis creates heat energy Even if the same coffee is roasted to the same roast colour you can get very different sensorial results if the shape and timing in the roast profile is different Roasting 'Defects' are worst case deviation from 'nice' profile Cooling time should practically be as short as possible		(Baggenstoss et al. 2007; Illy & Viani 2005) p. 179ff + 192 (Illy & Viani 2005; Clarke & Vitzthum 2001) p. 90ff (Clarke & Vitzthum 2001; Jansen 2006) p. 14ff (Belitz et al. 2009; Huschke 2007) p. 20ff (Jansen 2006; Belitz et al. 2009) p. 940-943 Pdf with SCAE roast log
2.01.02	Visually and sensorial identify roast defects (fast, scorched, baked, underdeveloped) and know their causes in different places in the roast cycle Demonstrate the ability to design and execute different roast profiles		(Baggenstoss et al. 2007; Illy & Viani 2005) p. 179ff + 192 (Illy & Viani 2005; Clarke & Vitzthum 2001) p. 90ff (Clarke & Vitzthum 2001; Jansen 2006) p. 14ff (Belitz et al. 2009; Huschke 2007) p. 20ff (Jansen 2006; Belitz et al. 2009) p. 940-943 Pdf with SCAE roast log
2.02.01	**DRYING** Moisture leaves the beans during drying and goes from bean to the air between the beans that will become moist and get a higher specific heat capacity Temperatures are held low by evaporating water because evaporation is an endothermic process		(Illy & Viani 2005; Huschke 2007) p. 20ff (Clarke & Vitzthum 2001) p. 90ff Wiki: Heat_capacity
2.02.02	Visually identify beans at first crack. Combine inlet temperature and initial flame control during a roast profile to avoid: 1. Scorching of beans 2. Underdevelopment of beans		(Illy & Viani 2005; Huschke 2007) p. 20ff (Clarke & Vitzthum 2001) p. 90ff Wiki: Heat_capacity

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2.03.01	**ROASTING** When the coffee is dry, the temperature starts to rise quicker The bean mass goes into pyrolysis where primarily the Maillard process is active The Maillard reaction and Strecker degradation are the main contributors to CO_2 formation This CO_2 formation becomes an additional source of pressure build up		(Jansen 2006; Belitz et al. 2009) p. 94
2.03.02	Demonstrate how to design and apply a flame control strategy around first crack that: 1. Prepares the last part of the roast from first crack 2. Continues until the target colour is achieved		(Jansen 2006; Belitz et al. 2009) p. 94
2.04.01	**COOLING** In specialty coffee, air at room temp is typically sucked through the beans to cool them down In commodity coffee, water quenching is often used, which is an extremely rapid method that adds water to the roasting coffee to stop the roasting process quickly If only a small amount of water is added hardly no water will stay in the coffee, but if too much is used it will have a detrimental effect on coffee aroma quality and makes the coffee stale quicker		(Clarke & Vitzthum 2001; Illy & Viani 2005) p. 181 (Jansen 2006; Baggenstoss et al. 2007)
2.04.02	Operate an infrared thermometer to monitor cooling time Operate a total moisture meter to record and evaluate the moisture level in roasted bean Determine if the residual moisture content of roasted beans meets quality parameters that will allow for preservation of aroma and shelf life		(Clarke & Vitzthum 2001; Illy & Viani 2005) p. 181 (Jansen 2006; Baggenstoss et al. 2007)
3.0 BASIC PROPERTIES AND CHANGES			
3.01.01	Coffee is an organic substance. Green coffee has a high total moisture content: 8-12.5% Drying green coffee makes roasting possible. Pyrolysis is an exothermic anaerobe (does not need oxygen) process that drives a range of different chemical reactions that start around first crack		(Huschke 2007; Illy & Viani 2005) p. 179ff (Illy & Viani 2005; Clarke & Vitzthum 2001) p. 90ff (Clarke & Vitzthum 2001; Belitz et al. 2009) p. 938ff Pdf on calculating percentage of change

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3.01.02	Control the overall roasting process from green to roasted coffee at room temperature		(Huschke 2007; Illy & Viani 2005) p. 179ff (Illy & Viani 2005; Clarke & Vitzthum 2001) p. 90ff (Clarke & Vitzthum 2001; Belitz et al. 2009) p. 938ff Pdf on calculating percentage of change
3.02.01	**VOLUME CHANGE** Volume increases due to material gets soft when heated combined with water evaporating into steam and pyrolysis creates organic gasses + CO_2 A pressure is build-up by the evaporating water that will later be the primary driver of bean swelling. If this part is too slow (too low flame), the gas would leak before creating a pressure high enough to expand the bean and the coffee will be 'underdeveloped'. If this part is too quick (too high flame) the surface of the bean will be scorched		(Jansen 2006) p. 30f (Illy & Viani 2005) p. 180 (Huschke 2007; Clarke & Vitzthum 2001) p. 94
3.02.02	Distinguishing different crack intensities and how it depends on energy transfer speed, and make changes to the flame profile if the crack is not audible or just not loud enough Measure and compare volume before and after roasting		(Jansen 2006) p. 30f (Illy & Viani 2005) p. 180 (Huschke 2007; Clarke & Vitzthum 2001) p. 94
3.03.01	**WEIGHT CHANGE** Water in form of vapour and organic material is lost when converted into gas that leaves the material		(Illy & Viani 2005; Jansen 2006) p. 34 (Jansen 2006; Clarke & Vitzthum 2001) p. 94 Pdf on calculating percentage of change
3.03.02	Measure weight of green and roasted coffee and calculate the difference Calculate density and calculate density change from green to roasted coffee		(Illy & Viani 2005; Jansen 2006) p. 34 (Jansen 2006; Clarke & Vitzthum 2001) p. 94 Pdf on calculating percentage of change
3.04.01	**COLOUR CHANGE** The product of Maillard reaction (melanoidins) is brown and happens quickly after drying is finished slightly above 100° Celsius Know different industry standards for measuring colour. Some measure wavelength as well as reflection intensity		(Huschke 2007; Jansen 2006) p. 19 & 28f (Morgan & Brenig-Jones 2012; Huschke 2007) p. 24
3.04.02	Use different types of colour measurement equipment and interpret the value in terms of product development, laboratory roasting and regional/cultural differences in roast degree preferences		(Huschke 2007; Jansen 2006) p. 19 & 28f (Morgan & Brenig-Jones 2012; Huschke 2007) p. 24

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3.05.01	**SUGAR CHANGE** Caramelization happens at high temperature (closer to 200° Celsius) so the Maillard reaction is much more pronounced due to its lower activation temperature		(Tisbury 2012; Illy & Viani 2005) p. 193
3.06.01	**ACIDITY CHANGE** Acids are created very early in the process. The amount of different acids present in coffee changes as the roast degree continues. Most acids are reduced when darker, more typically commercial roast degrees are reached		(Illy & Viani 2005; Clarke & Vitzthum 2001) p. 18-30 (Clarke & Vitzthum 2001; Jansen 2006) p. 46-67, 57-61
3.06.02	Sensorial identify and rank acidity level. Use this sensory analysis as an indicator of roast level		(Illy & Viani 2005; Clarke & Vitzthum 2001) p. 18-30 (Clarke & Vitzthum 2001; Jansen 2006) p. 46-67, 57-61
4.0 MACHINE CONSTRUCTION			
4.01.01	Drum Roaster Fluid Bed Roaster Batch vs. Continuous Roaster		(Huschke 2007; Illy & Viani 2005) p. 184ff (Jansen 2006; Huschke 2007) p. 27ff
4.01.02	Understand the basic differences in design of commonly found roasters including: • Horizontal drum Roaster • Fluid Bed Roaster • Continuous Roaster Demonstrate an ability to safely experiment with any type of roasters to achieve a desired result based on cupping		(Huschke 2007; Illy & Viani 2005) p. 184ff (Jansen 2006; Huschke 2007) p. 27ff
4.02.01	**VENTILATION** *In the roast chamber:* the airflow mixes the hot air into the batch of beans and creates convention heat transfer *In the chimney:* Avoid resistance (length + bends). Organic build up adds resistance and increases fire risk	L4	Consult the manual for a given roaster for specifications and requirement for installation, maintenance of ventilation system
4.02.02	Explain how to install an exhaust chimney without causing problems, such as resistance that can lead to fire Demonstrate knowledge of methods that can be used to maintain roaster exhausts, such as chimney sweeps	L4	Consult the manual for a given roaster for specifications and requirement for installation, maintenance of ventilation system
4.03.01	**ELECTRICITY** Electrical burners possible on small (batch size 12 and less) roasters Electrical heating elements are slow, but are fine for roasting Electricity always drives motors and general control circuits		

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4.03.02	Plan roast profiles on gas and electrical roasters and understand how to compensate for differences in timing		
5.0 WORKSPACE MANAGEMENT			
5.01.01	Green coffee storage (60% relative humidity - 12% bean) Roaster, de-stoner, packing area, one-way valve bags, air filters, Lean management (5S) Production flow	L4	(Morgan & Brenig-Jones 2012; Illy & Viani 2005) p. 111 (Clarke & Vitzthum 2001; Jansen 2006) p. 12
5.01.02	Plan a work space for: • roasting • packing • maintenance • cleaning • laboratory analysis	L4	(Morgan & Brenig-Jones 2012; Illy & Viani 2005) p. 111 (Clarke & Vitzthum 2001; Jansen 2006) p. 12
5.02.01	**TOOLS FOR ROASTING** Food grade equipment to support product handling such as: • buckets/bins for green and roasted beans (buffers) • shovel/scoops for green and roasted coffee Other equipment to support the roasting process includes: • Logging sheets/software • Timer • Temperature probes • Hand held thermometer (infrared) • Moisture, density meters • Roast colour meters • Scales It is important to organize the work place so that you can store green and roasted coffee in safe containers with full batch traceability Ergonomic tools are available for handling coffee A quality control system, either manual pen-and-paper or logging software, is important for both food safety and quality Basic lab equipment to monitor quality of green and roasted coffee supports roasted product safety, quality and consistency over time	L3	(Illy & Viani 2005; Huschke 2007) p. 6-7 + 65
5.02.02	Understand that coffee is a food product Explain the use of various supporting tools and equipment and their application to coffee roasting	L3	(Illy & Viani 2005; Huschke 2007) p. 6-7 + 65

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5.03.01	**CLEANING, MAINTENANCE & TROUBLESHOOTING** Cleaning and maintenance schedule	L3	Should be described in the machine's instructions manual (Jansen 2006; Morgan & Brenig-Jones 2012) p. 151 (Belitz et al 2009; Tisbury 2012)
5.04.01	**VENTILATIONS** Highly flammable dry organic material builds up inside the ventilation system. Unfortunate consequences are: resistance to airflow if the tubes are clogged and fire risk! Depending of the brand of roaster and ventilation system, cleaning of the inside of the pipes should be done every 2 to 6 months Install clean out doors at appropriate areas of the chimney where build-up is forming, so that it is easy to clean		
5.04.02	Plan the ventilation aspect of a coffee roaster installation with respect to quality of the roasting process, variation and fire prevention and extinguishing		
5.05.01	**CHAFF COLLECTOR** The silver skin of the green beans fall off during roasting because the coffee beans expand and open up. This silver skin is called chaff in roasted coffee and is collected in below a cyclone made for the purpose called 'Chaff collector'	L3	
5.05.02	Plan fire prevention and extinguishing Be aware that chaff collectors are a very typical place for fires to start	L3	
5.06.01	**EXHAUST AIR CLEANING** A number of methods are available in the marketplace for cleaning exhaust air. These include: • Afterburner • Electro static • Ceramic beds • Ozone • UV light • Water curtain • Recycling exhaust air into burner		
5.06.02	Plan appropriate exhaust cleaning to reduce needed frequency for chimney sweeping, reduced fire risk and reduced risk for neighbour complaint due to coffee roast odour in the neighbourhood		

SUB CODE	KNOWLEDGE/SKILL REQUIRED	STANDARDS	REFERENCE
5.07.01	**COOLING TRAY** Coffee should be hand warm maximum 5 minutes after roasting Cooling tray screen should be cleaned regularly to keep cooling time down. Expect season variation on cooling time, as the surrounding air is involved in the cooling process		
5.07.02	Obtain appropriate tool and maintenance plan for keeping the cooling tray holes clean, to avoid reduced airflow in cooling tray due to clogged holes Install inexpensive extra fans can speed up the cooling process by blowing onto the cooling coffee		

Key Terminology

Word or Term	Proposed Description	Source
1st and 2nd crack		
8-12% moisture in green beans		
After burner		
Air (drum environment) temperature probe		
Airflow, chimney		
Bean temperature probe		
Buildup in chimney – Fire risk!		
Chaff. Chaff collector		
Charge/Drop temperature		
Conduction/contact/diffusion, radiation and convection heat transfer		
Cooling phase / Cooling time		
Cooling tray		
Dark roast high bitterness low in acidity. Opposite relationship for light roasts		
De-stoner		
Development time (from first crack to end of roast)		
Dropping temperature		
Drum rotation		
Drying phase		
Electrostatic filter		
End temperature		
Endothermic		

Word or Term	Proposed Description	Source
Evaporation is endothermic		
Exhaust filtration		
Exothermic		
Fire extinguisher (Water vs CO2)		
Fire in the chimney		
Fire in the drum		
Fluid bed roaster		
Grade. Screen. Bean size variation		
Heat vs Temperature		
Lean production		
Maillard reaction		
Moist vs Dry period		
Moisture meter		
Myco toxins		
Natural processing		
Organic acids creation and degradation		
Percentage change		
Pre-blending vs Post-blending		
Processing		
Profile logging software		
Pupled Natural		
Pyrolysis		
Quenching		
Rate of Rise		
Reducing points		

Word or Term	Proposed Description	Source
Roast air temperature vs Product temperature		
Roast colour meter		
Roast defects (scorched, baked, underdeveloped)		
Roast degree / roast colour		
Roast gases		
Roast logging system		
Roast loss		
Roast loss, Volume increase, density drop		
Roast profile (time x temp)		
Roasting curve		
Roasting cycle		
Roasting drum		
Roasting process		
Silver skin		
Slow roast vs Flash roast		
Storage conditions 12% bean moisture vs 60% RH in storage room		
Sweet spot		
Turning point (minimum profile temperature)		
Ventilation		
Washed coffee		