CITRUS PROCESSING TECHNICAL GLOSSARY

% acid – Total acidity determined as anhydrous citric acid, expressed as a percentage of total solution by weight. Most orange juice in the U.S. is less than 1% acid. Most grapefruit juice is 1% or slightly higher.

% oil in juice – The amount of oil incorporated into the juice from the peel during extraction. This oil makes its way into the juice stream through the peel plugs produced during extraction by the upper and lower cutters. Some amount of oil is desired to impart good flavor characteristics to orange juice. Excessive amounts of oil in fresh juice is a defect. Grade "A" fresh juice should not exceed 0.03% oil. For concentrate, oil is not an issue because volatilization or "flashing off" of oil occurs during thermal processing, creating a need to actually add back oil to create an acceptable final product.

°Brix – A measure of all soluble solids in the juice. Although they make up the bulk of the solids present, °Brix is not a measure of sugar content only. Typical values range from 8 to 14°Brix in oranges, 8 to 12°Brix in grapefruit. During concentration °Brix increases.

ACUS – Automatic Clean-Up System. Typically refers to the computer controlled clean-up system for JBT Citrus Juice Extractors.

ACUS II – Designation for automatic clean–up systems for wide variety of citrus processing sub–systems, i.e., pulp wash system, oil recovery system, etc.

albedo – The spongy layer of white cells found just under the flavedo or outer colored portion of the peel. This layer is rich in **pectin** and hemicellulose.

available oil – The amount of oil in the whole orange, grapefruit, etc., recorded as lbs oil per ton of fruit. Grapefruit generally range from 5 to 8 lbs/ton fruit while Florida oranges can range from 6 to 16 lbs/ton fruit. Available oil has a direct relationship to **% oil in juice** and total oil recovery.

Baumé – An arbitrary scale of specific gravity used in the graduation or calibration of hydrometers.

box – Also referred to as standard or field box. In the citrus industry fruit is sometimes bought or sold by the box rather than pounds or tons. The standard box of oranges weighs 90 lbs. of oranges and yields approximately 5.5 gallons of juice; the standard box of grapefruit weighs 85 lbs. There is no standard for lemons or limes.

bottom pulp (sinking pulp) – The pulp that is recorded from a centrifuged sample of juice. Excessive pulp (14% or more) is an indication of high pressures used in extraction and finishing of the juice. Also, overmature fruit or freeze damaged fruit can result in large amounts of bottom pulp. Also referred to as "fines". The procedure to determine the amount of sinking pulp in juice involves centrifuging 50 ml of screened juice (to remove coarse floaters) for 10 minutes at 1500 rpm and reporting as a percentage of volume. Typical values range from 8 to 14% bottom pulp.

caustic – Refers to any of a number of basic or alkaline (see **pH**) materials. For our purposes, NaOH (sodium hydroxide) and KOH (potassium hydroxide) are caustics, the opposite of acids on the pH spectrum. They never should be mixed with acids due to the resulting violent chemical reaction. Caustics are excellent cleaners for juice residue.

CITRUS PROCESSING TECHNICAL GLOSSARY

centrifuged pulp – See “bottom pulp”.

cloud – The presence of cloud is an important quality attribute of most citrus juices. The pectic substances in citrus juices contribute to the cloud of the juice by suspending insoluble particles in the liquid. Loss of the soluble pectin causes the precipitation or falling out of suspended solids. The juice separates into a cloudy to clear upper layer and a bottom sediment of solid particles. Cloud is measured by decanting or pouring off the partially clarified liquid after centrifugation and observing the amount of light that can pass through it with a colorimeter or spectrophotometer and recording as light transmittance.

cold pressed peel oil – The oil derived from extraction of citrus fruits. Oil cells are found in the surface of the peel. In the JBT citrus juice extractor these are ruptured during extraction, making the oil available for recovery by mechanical means (as opposed to thermal processing). With the JBT extraction process, oil cells burst primarily during the first stages of pressure application to the fruit as the cups begin to mesh. Cold pressed peel oil is an important by–product in citrus juice processing.

color score – The score given to citrus juices which is traditionally determined by the use of a Hunter citrus colorimeter. By reading the color red and color yellow components of the sample in direct comparison to a USDA standard, a “score” can be assigned. Keep in mind that the color orange is a proportional mix of both red and yellow.

concentrate – The product obtained from a process in which water is removed from a fruit juice (or other heat labile material) by utilizing heat under vacuum conditions. Orange concentrate is normally concentrated to 65°Brix which has the soluble solids content of 7 equal volumes of orange juice at 11.8°Brix. 65°Brix concentrate is also referred to as a 7 fold or a 1 + 6 concentrate. Concentrates of this type are relatively void in orange flavor as the orange oil and volatile flavors are removed with the water. For this reason, concentrates are almost always used for blending into retail products whereby the flavor can be restored through the addition of orange oil and essences and/or fresh orange juice.

Concentrates offer many advantages such as significant savings in storage, transportation, and availability of year–round processing. Other processes such as freeze concentration and membrane technologies exist to concentrate juices; however, these technologies are rather expensive and have not proven economically feasible.

core wash – The process by which soluble solids are recovered from the orifice discharge through a system of mixing screws and countercurrent staged finishers. Soluble solids are leached from the cores in each stage by attaining equilibrium with the liquid from the next downstream stage. Water is added to the last stage.

Davis Value – The numerical value determined by the Davis test which measures the amount of **naringin** in grapefruit juice. Naringin is the major contributor to the bitterness of grapefruit juice. Naringin levels in grapefruit juice are affected by fruit quality and maturity, as well as the extraction pressure applied to the fruit during processing.

defects – Characteristics that detract from citrus product quality. The presence of embryonic seeds or specs in juice, poor color score, and out of range ratios are examples of defects.

CITRUS PROCESSING TECHNICAL GLOSSARY

Diacetyl – One of several undesirable substances formed during processing or storage. Its cause is an acid–forming bacteria that imparts a “buttermilk” odor if the concentration exceeds 1.0 ppm. This is formed as a natural by–product of the fermentation process.

d–limonene – A terpene which makes up 90-95% of cold pressed peel oil. The oil derived from the flavedo or outer surface of the peel of oranges consists of 90% d–limonene. This important by–product is also recovered from the waste heat evaporator in the feed mill when concentrating press liquor into molasses.

enzyme activity – The enzyme **pectinesterase** acts upon the desirable cloud forming pectin causing clarification and separation in a short time at room temperature. Careful application of heat will inactivate this enzyme and stabilize the juice, thereby reducing “enzyme activity” and producing a more homogenous product. Pectinesterase is found primarily in the pulp and membranes.

enzymes – Globular proteins which catalyze various biochemical reactions. In citrus, the enzyme of greatest commercial importance is pectinesterase. Pectinesterase activity reduces juice quality by increasing viscosity, gel formation and loss of cloud.

FCOJ – Frozen Concentrated Orange Juice. In U.S. retail form it is sold at 42°Brix. Commercially, it is concentrated to 65°Brix before being “cut back” with single strength juice to its retail form. See “**concentrate**”.

flavedo – Consists of the colored outer portion of the peel. In the flavedo are found the oil glands or cells that contain the essential oil and the carotenoids which impart the color found in a particular fruit.

fresh juice – In Florida refers to extracted juice which has not been heat treated (pasteurized or concentrated), frozen, or altered in any means. Typically refers to juice as it comes directly from the extractor.

frit – The small pieces of peel produced by the JBT extraction principle that are washed into the oil recovery stream down the bridge of the extractor.

GC – Gas Chromotography. Columnar chromotography using gases such as helium, nitogen or argon as the mobile phase to carry the sample through the column whereby components are separated. Sample must be volatile or derivatized to be analyzed by GC. GC typically used to analyze flavor profile of juices.

gelation – The tendency of concentrate to become lumpy and difficult to reconstitute is known as gelation and is a result of pectinesterase activity. Present day evaporators rarely fail to inactivate these enzymes and this defect is all but eliminated. However, when unpasteurized fresh juice is used as “cut back” in the production of concentrate, this defect can still occur.

hesperidin – An extremely insoluble flavonoid that precipitates and accumulates on evaporators and extractors as a white to yellowish coating. This substance is easily removed with a 2% caustic solution. It imparts no off flavor to juices; however, it may show up in FCOJ as white specks and is considered a defect reflected in the grade of the product.

CITRUS PROCESSING TECHNICAL GLOSSARY

HPLC – High Pressure Liquid Chromatography. Column chromatography that uses high pressure pump to move the liquid mobile phase as means to separate various components of the sample. HPLC is typically used to analyze **limonin** and **naringin**.

limonin – A complex compound that is a major bitter component in citrus products, especially navel orange juice. After juice extraction takes place, limonin forms from a non–bitter precursor compound found primarily in the seeds and section membrane. Time and increased temperature can increase limonin levels in citrus juice. Concentrations of 5.0 ppm and above have a marked effect on the bitterness of the juice. The JBT extraction principle produces juice low in limonin levels due to the instantaneous separation of the seeds and membrane from the juice during extraction.

naringin – The primary flavonoid that contributes directly to the characteristic bitter taste of grapefruit juices. This bitter flavor compound is measured by the use of the Davis Test or HPLC.

NFC – Not-from-Concentrate. Freshly extracted single strength juice which is pasteurized and chilled to increase shelf life. An increasingly popular form of retail orange and grapefruit juices that sells at a premium price compared to FCOJ or reconstituted single strength juices. Often confused with fresh juice by the consumer.

oil emulsion – Consists of emulsified citrus oil in water. The water typically comes from the spray ring located at the upper cup adapter of the extractor.

oil slurry – A slurry consisting of the oil captured at the spray rings, the water used to recover this oil, and the small pieces of peel (referred to as **frit**) produced during the extraction process.

orifice discharge – The portion of the fruit that is discharged out the bottom of the orifice tube during extraction. It consists primarily of the fruit membranes, core material, and seeds.

pasteurization – A heat treatment that kills some but not all of the microorganisms present in juice in order to minimize microbial growth in subsequent handling and storage. A temperature of 70°C for one minute is required to sufficiently reduce the microbial load in orange juice. Pectinesterase inactivation requires a minimal heat treatment 90°C for 10 seconds.

POJ – Pasteurized Orange Juice. See “Pasteurization”. Primarily used in production of Not–From–Concentrate (NFC) orange juice.

pectin – A naturally occurring colloidal stabilizer that gives juice its “body” or viscosity. Pectin is most abundantly found in the albedo but also found in other fruit components.

percent of State Test – A relative measure of juice yield in comparison to a constant. The JBT Model 091 juice extractor is the accepted standard by which all extraction methods are compared. Beam setting, restriction, cups, cutters and strainer tubes are all monitored by the State to assure consistency at each State Test house.

pH (potential of Hydrogen) – A measure of the acidity or the alkalinity of a solution. Citric acid, which is present in citrus juices, gives a low pH reading (approximately 3–4). The caustics used in clean–up, i.e. NaOH, KOH, give high pH readings (approximately 8–12). A pH of 7 is considered neutral.

CITRUS PROCESSING TECHNICAL GLOSSARY

plate count – A method for determining the microbial activity level in a sample, i.e. juice. A series of dilutions are made from the sample and a small amount (0.1 to 0.3 ml) of the dilutions are plated, using sterile technique, on a growth medium (orange serum agar for orange juice). The plates are incubated and those containing between 30 to 300 colonies are counted and multiplied by their dilution factor. The other plates are discarded. Plate count is recorded as CFU/ml (Colony Forming Units per ml).

pounds juice per box – The actual weight in pounds of juice extracted per 90 lb. box of fruit as measured by the State Test extractor. State values for pounds juice per box are adjusted by a factor system.

pounds solids per box – A measure in weight, of the total dissolved sugar solids in a given box of fruit. Pounds solids per box increases with degrees Brix and/or lbs. juice per box.

pounds solids per box = (°Brix) x (pounds of juice per box)

premium juice – See "**NFC**".

premium pulp – Usually refers to intact pulp sacs ranging in size from 5mm to 20mm. Premium pulp typically retains floating characteristics. Premium pulp is recovered and added back to finished juice product to give juice a freshly squeezed texture and appearance.

press liquor – Product stream obtained by screw pressing moisture from the citrus peel. Press liquor is concentrated in a waste heat evaporator to form molasses.

pulp wash – The process by which soluble juice solids are recovered from finished pulp through a system of mixing screws and countercurrent staged finishers. Soluble solids are leached from the pulp in each stage by attaining equilibrium with the liquid from the next downstream stage. Water is added to the last stage. Extract from the pulpwash system can be added back to the primary juice prior to evaporation in order to increase juice yield or it can be evaporated separately. Product from a pulp wash system is referred to as secondary solids, pulp wash, or WESOS (Water Extracted Soluble Orange Solids).

quick fiber – A measure of the relative dryness of pulp as it exits the finisher. If the finisher setting is too loose, juice is lost to the pulp wash stream; if too tight, the finished juice may be of a lower quality. The quick fiber test takes a known quantity of pulp (200 g) and adds an equal amount of water, mixes it, and agitates through a screen. The water is then recovered to see if it was absorbed by the pulp or if free juice was given up by the pulp. A value of 160 means that 40 grams of the original water added was absorbed and is a typical moderate value.

ratio – Ratio of ˚Brix to % acid in citrus juice.

$$°Brix \div \%\ acid = ratio$$

Citrus fruits do not have a well–defined or obvious maturity point as do most fruit; however, ratio acts as a surrogate maturity indicator. Orange ratios are typically found in the 11.5 to 19.5 range while grapefruit ratios are normally 6 to 10.

CITRUS PROCESSING TECHNICAL GLOSSARY

ready-to-serve – See "**single strength**".

screened pulp – This refers to the pulp cells large enough to be retained by a 20 mesh screen or a 60 mesh screen (20 or 60 equal openings per linear inch, respectively). Excessive amounts of 20 mesh screened pulp, also called "sensible pulp", can be an indication that a finisher screen has a large hole in it or is leaking pulp into the juice around the edge of the screen frame. Excessive amounts of 60 mesh pulp, also called "fines" or "fine pulp", can be an indication that pulp is being extruded through the finisher screens due to excessive finisher gate pressure or low juice flow.

single strength – Term used to denote juices which are in "ready–to–serve" form of approximately 11.8°Brix. NFC, fresh, and reconstituted juices are examples of single strength juice.

solids, insoluble – Consist mostly of cellulosic and insoluble pectic substances generally associated with the pulp. Simply put, solids that will not go into solution.

solids, soluble – Solid materials that will go into a solution. Sugars in citrus juices are commonly referred to as soluble solids.

specific gravity – The ratio of the density of any substance to the density of a standard material, water being the standard for liquids and solids. Citrus oils are less dense than water and therefore have a lower specific gravity, thus explaining their tendency to separate. This phenomenon is enhanced by gravitational force or inertial application as is found in centrifugation. Citrus juices are heavier than water per unit volume due to the soluble solids (sugars) found in them. Their specific gravity would be greater than 1.0.

State Test Factor – The correction factor used by the Florida Department of Agriculture that reflects maturity of grapefruit based on the date they are processed**.** This value is used in calculating juice yields in conjunction with % of State Test values as determined by the state.

For example: In December the State Test factor for grapefruit is 91. If the State Test house extracts 22 lbs. of juice from a 45 lb fruit sample, they would multiply the measured juice yield per box by .91 and report that figure as the State Test juice yield.

$$\frac{22 \text{ lbs juice}}{45 \text{ lbs fruit}} * \frac{85 \text{ lbs fruit}}{\text{box}} * (.91) = \frac{37.8 \text{ lbs juice}}{\text{box}} = \text{State Test}$$

If the processor squeezed 40 lbs of juice per box from the same load of fruit, then his yield would be 105.8% of State Test.

$$\frac{40 \text{ lbs juice per box}}{37.8 \text{ lbs juice per box at State Test}} * 100 = 105.8\% \text{ of State Test}$$

See "% of State Test".

strong liquor – Process stream resulting from a water extraction process that is of a higher concentration. Example: The strong liquor from a pulp wash system.

CITRUS PROCESSING TECHNICAL GLOSSARY

suspended pulp – See “bottom pulp”.

TASTE Evaporator – Thermally Accelerated Short Time Evaporator. Evaporators originally used for concentration needed approximately 90 minutes to reach commercially desired Brix levels. The TASTE evaporator, by using a number of stages and temperature variations, needs only 6 to 7 minutes to accomplish the same job, resulting in a superior quality product with a less pronounced “cooked” flavor.

viscosity – Viscosity is a measure of the “thickness” of a fluid. It affects the “body” of the juice created primarily by pectin related stabilization of the cloud or colloids in the juice. The presence of insoluble material also contributes to increased body or viscosity.

volumetric pulp – See “bottom pulp”.

waste heat evaporator – Evaporator which captures exhaust heat from kiln dryers used for peel processing. This device concentrates press liquor into citrus molasses.