STATION 13: JUICE HEATING AND EVAPORATION pdf

1: Evaporate | Science project | www.enganchecubano.com

Concentration on evaporation station. The heart of the line for producing fruit concentrates is multi-staged evaporation station with a dropping juice film used for condensing apple juice and soft.

The program targets students countrywide who are attending secondary and tertiary institutions. Its aim is to sharpen the skills of young students who will join the working world in the near future. This opportunity allows them to gain experience in their different fields of study. Numerous applications for the program are submitted every year with BSI hosting one set of students in the first month and another set in the second month. Most interns whose majors involved business management and accounting were posted in the administrative offices whereas students whose major included laboratory and engineer work were posted at the factory. In some cases, interns did both field work and office work, which allowed them to broaden their experience in both environments. BSI is proud to have been hosting this program for over a decade knowing that empowering the minds of young people leads to a better community and leaves students with a wider knowledge of what their careers have in store for them. One of the reasons students seek this opportunity is because it allows them to be productive during the summer. Internships, which are required in order to graduate from their field, are amongst the reasons some students choose to take on this work opportunity at BSI. The program also assists in covering school expenses as acquiring an education is also costly. Posted on October 1, by Asr Bsi. Cane Reaping and Transport It has been realized for many years that producing and exporting sugar from Belize incurs higher costs than its competing countries. In particular the long standing sugar price support from the European Union is to be discontinued in In Belize, cane is mainly grown by a large number of relatively small scale independent farmers. The costs of reaping and delivering cane to Tower Hill are very high by international standards. The high reaping costs are partly caused by there being excess cane loaders and trucks in the Tower Hill cane catchment area, with subsequent severe under-utilization. Reaping Groups There are currently registered reaping groups. Reaping groups are frequently family-based. Mechanical Loading At present each reaping group operates one grab loader. These units vary between old tractor-mounted units to the purpose-built 4wd Cameco SP Cane Transport Units It is estimated that there are over cane transport units currently in the system. The productivity of the delivery units mainly trucks to Tower Hill is very low and therefore expensive. These trucks are capable of making 2 â€” 3 trips per shift to the mill, equating to 6 trips per day or more. The one load per day restriction is also adversely affecting cane quality as the cane is waiting in the trucks for too long. The delivery by appointment system has reduced truck queues at the factory but many loaded trucks are still parked in the villages for up to 24 hours. Recommendations Amalgamation of reaping groups into larger units would be economically beneficial without incurring adverse effects. One load per day cannot pay the fixed and variable costs of operating a truck. Changes in the scheduling and sampling system could be made to first allow at least two deliveries per truck per day. Each half would then deliver t, which is regarded as the current minimum sample size. This split delivery would permit two loads per truck per day. Once the concept of two deliveries per day per truck by larger reaping groups became accepted the number of cane trucks in the district could be reduced. Truck productivity in the existing multi-truck reaping groups could be improved immediately by increasing truck capacity buy larger trucks or fit a trailer to a 10 wheeler and reducing the number of trucks. In addition, a mechanism must be found to allow several trips in a day preferably with the largest possible trucks. It is therefore essential for the future of both the cane farmers and the miller that reaping costs are reduced. If this cannot be achieved there will be a major threat to the ongoing existence of the whole sugar industry in Belize. As can be noted, after an evident drop in rainfall from January to February , there was a slight increase in rainfall from March to April of The month of May had recorded the lowest rainfall than in previous years with Rainfall increased significantly to mm of rain in the month of June , proving to be the highest recorded amount of rainfall for the year thus far. Rainfall dropped significantly to

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2: Evaporators | Dairy Processing Handbook

Evaporation is the process of water transferring from a liquid to a gas and is the primary method for water to move into the atmosphere during the water cycle. Scientists believe that the earth's oceans, seas, lakes and rivers provide % of the moisture in the atmosphere.

Save Class A evaporation pan Pan evaporation is a measurement that combines or integrates the effects of several climate elements: Evaporation is greatest on hot, windy, dry, sunny days; and is greatly reduced when clouds block the sun and when air is cool, calm, and humid. Such pans are of varying sizes and shapes, the most commonly used being circular or square. Often the evaporation pans are automated with water level sensors and a small weather station is located nearby. Standard methods A variety of evaporation pans are used throughout the world. There are formulas for converting from one type of pan to another and to measures representative of the environment. The pan rests on a carefully leveled, wooden base and is often enclosed by a chain link fence to prevent animals drinking from it. Evaporation is measured daily as the depth of water in inches evaporates from the pan. At the end of 24 hours, the amount of water to refill the pan to exactly two inches from its top is measured. If precipitation occurs in the hour period, it is taken into account in calculating the evaporation. Sometimes precipitation is greater than evaporation, and measured increments of water must be dipped from the pan. Analysis of the daily rainfall and evaporation readings in areas with regular heavy rainfall events shows that almost without fail, on days with rainfall in excess of 30mm mm Rain Gauge the daily evaporation is spuriously higher than other days in the same month where conditions more receptive to evaporation prevailed. The less obvious, and therefore more concerning, is the influence of heavy or intense rainfall causing spuriously high daily evaporation totals without obvious overflow. Evaporation from a Sunken Colorado Pan can be compared with a Class A pan using conversion constants. The pan coefficient, on an annual basis, is about 0. For decades, pan evaporation measurements were not analyzed critically for long term trends. But in the s scientists reported that the rate of evaporation was falling. Since the local moisture level has increased in the local terrain, less water evaporates from the pan. This leads to false measurements and must be compensated for in the data analysis. Models accounting for additional local terrain moisture match global estimates. Pan Evaporation Pan evaporation is used to estimate the evaporation from lakes. Most textbooks suggest multiplying the pan evaporation by 0. However, the significance of this negative trend, as regards terrestrial evaporation, is still somewhat controversial, and its implications for the global hydrologic cycle remain unclear. The controversy stems from the alternative views that these evaporative changes resulted, either from global radiative dimming, or from the complementary relationship between pan and terrestrial evaporation. Actually, these factors are not mutually exclusive but act concurrently.

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3: Newsletter Vol. 5 â€" Belize Sugar

Steam that is used to heat juice in the evaporator station comes from the boilers that are from the power plant station. Steam from the boilers will be at a pressure of psi.

Common sources of Legionella include cooling towers used in open recirculating evaporative cooling water systems, domestic hot water systems, fountains, and similar disseminators that tap into a public water supply. Natural sources include freshwater ponds and creeks. That outbreak killed 21 of the 86 people who had a laboratory-confirmed infection. Drift eliminators are used in order to hold drift rates typically to 0. A typical drift eliminator provides multiple directional changes of airflow to prevent the escape of water droplets. A well-designed and well-fitted drift eliminator can greatly reduce water loss and potential for Legionella or water treatment chemical exposure. The CDC does not recommend that health-care facilities regularly test for the Legionella pneumophila bacteria. Scheduled microbiologic monitoring for Legionella remains controversial because its presence is not necessarily evidence of a potential for causing disease. The CDC recommends aggressive disinfection measures for cleaning and maintaining devices known to transmit Legionella, but does not recommend regularly-scheduled microbiologic assays for the bacteria. However, scheduled monitoring of potable water within a hospital might be considered in certain settings where persons are highly susceptible to illness and mortality from Legionella infection e. Also, after an outbreak of legionellosis, health officials agree that monitoring is necessary to identify the source and to evaluate the efficacy of biocides or other prevention measures. Tower is shut down, revealing numerous water spray heads. Windage or Drift â€" Water droplets that are carried out of the cooling tower with the exhaust air. Drift droplets have the same concentration of impurities as the water entering the tower. The drift rate is typically reduced by employing baffle-like devices, called drift eliminators, through which the air must travel after leaving the fill and spray zones of the tower. Drift can also be reduced by using warmer entering cooling tower temperatures. Blow-out â€" Water droplets blown out of the cooling tower by wind, generally at the air inlet openings. Water may also be lost, in the absence of wind, through splashing or misting. Devices such as wind screens, louvers, splash deflectors and water diverters are used to limit these losses. Plume â€" The stream of saturated exhaust air leaving the cooling tower. Under certain conditions, a cooling tower plume may present fogging or icing hazards to its surroundings. Note that the water evaporated in the cooling process is "pure" water, in contrast to the very small percentage of drift droplets or water blown out of the air inlets. Draw-off or Blow-down â€" The portion of the circulating water flow that is removed usually discharged to a drain in order to maintain the amount of Total Dissolved Solids TDS and other impurities at an acceptably low level. Higher TDS concentration in solution may result from greater cooling tower efficiency. However the higher the TDS concentration, the greater the risk of scale, biological growth and corrosion. The amount of blow-down is primarily designated by measuring by the electrical conductivity of the circulating water. Biological growth, scaling and corrosion can be prevented by chemicals respectively, biocide, sulfuric acid, corrosion inhibitor. On the other hand, the only practical way to decrease the electrical conductivity is by increasing the amount of blow-down discharge and subsequently increasing the amount of clean make-up water. Zero bleed for cooling towers, also called zero blow-down for cooling towers, is a process for significantly reducing the need for bleeding water with residual solids from the system by enabling the water to hold more solids in solution. Noise â€" Sound energy emitted by a cooling tower and heard recorded at a given distance and direction. The sound is generated by the impact of falling water, by the movement of air by fans, the fan blades moving in the structure, vibration of the structure, and the motors, gearboxes or drive belts. Approach â€" The approach is the difference in temperature between the cooled-water temperature and the entering-air wet bulb temperature twb. Since the cooling towers are based on the principles of evaporative cooling, the maximum cooling tower efficiency depends on the wet bulb temperature of the air. The wet-bulb temperature is a type of temperature measurement that reflects the physical properties of a system with a mixture of a gas and a vapor, usually air and water vapor Range â€" The range is the temperature difference between the warm water inlet and cooled water exit. Fill â€" Inside the tower, fills are added to increase contact surface as well as contact time between air and water, to provide better heat transfer. The efficiency of the tower depends on the selection and amount of fill. There are two types of fills that may be used: Film type fill causes water to spread into a thin film Splash type fill breaks up falling stream of water and interrupts its vertical progress Full-Flow Filtration â€" Full-flow filtration continuously strains particulates out of the entire system flow. In this case, the filter typically is installed after the cooling tower on the discharge side of the pump. While this is the ideal method of filtration, for higher flow systems it may be cost-prohibitive. Side-Stream Filtration â€" Side-stream filtration, although popular and effective, does not provide complete protection. With side-stream filtration, a portion of the water is filtered continuously. This method works on the principle that continuous particle removal will keep the system clean. Manufacturers typically package side-stream filters on a skid, complete with a pump and controls. For high flow systems, this method is cost-effective. Properly sizing a side-stream filtration system is critical to obtain satisfactory filter performance, but there is some debate over how to properly size the side-stream system. Cycle of concentration â€" Maximum allowed multiplier for the amount of miscellaneous substances in circulating water compared to the amount of those substances in make-up water. Treated timber â€" A structural material for cooling towers which was largely abandoned about 10 years ago. The life of treated timber varies a lot, depending on the operating conditions of the tower, such as frequency of shutdowns, treatment of the circulating water, etc. Under proper working conditions, the estimated life of treated timber structural members is about 10 years. Leaching â€" The loss of wood preservative chemicals by the washing action of the water flowing through a wood structure cooling tower. Pultruded FRP â€" A common structural material for smaller cooling towers, fibre-reinforced plastic FRP is known for its high corrosion-resistance capabilities. Pultruded FRP is produced using pultrusion technology, and has become the most common structural material for small cooling towers. It offers lower costs and requires less maintenance compared to reinforced concrete, which is still in use for large structures. Fog clouds produced by Eggborough Power Plant UK Under certain ambient conditions, plumes of water vapor fog can be seen rising out of the discharge from a cooling tower, and can be mistaken as smoke from a fire. If the outdoor air is at or near saturation, and the tower adds more water to the air, saturated air with liquid water droplets can be discharged, which is seen as fog. This phenomenon typically occurs on cool, humid days, but is rare in many climates. Fog and clouds associated with cooling towers can be described as homogenitus, as with other clouds of man-made origin, such as contrails and ship tracks. For that purpose, in hybrid towers, saturated discharge air is mixed with heated low relative humidity air. Some air enters the tower above drift eliminator level, passing through heat exchangers. The relative humidity of the dry air is even more decreased instantly as being heated while entering the tower. The discharged mixture has a relatively lower relative humidity and the fog is invisible. The salt deposition problem from such cooling towers aggravates where national pollution control standards are not imposed or not implemented to minimize the drift emissions from wet cooling towers using seawater make-up. Similarly, particles smaller than 2. Though the total particulate emissions from wet cooling towers with fresh water make-up is much less, they contain more PM10 and PM2. At plants without flue gas purification, problems with corrosion may occur, due to reactions of raw flue gas with water to form acids. Sometimes, natural draft cooling towers are constructed with structural steel in place of concrete RCC when the construction time of natural draft cooling tower is exceeding the construction time of the rest of the plant or the local soil is of poor strength to bear the heavy weight of RCC cooling towers or cement prices are higher at a site to opt for cheaper natural draft cooling towers made of structural steel. Operation in freezing weather[edit] Some cooling towers such as smaller building air conditioning systems are shut down seasonally, drained, and winterized to prevent freeze damage. Basin heaters, tower draindown, and other freeze protection methods are often employed in cold climates. Operational cooling towers with malfunctions can freeze during very cold weather. Typically, freezing starts at the corners of a cooling tower with a reduced or absent heat load. Severe freezing conditions can create growing volumes of ice, resulting in increased structural loads which can cause structural damage or collapse. To prevent freezing, the following procedures are used: The use of water modulating by-pass systems is not recommended during freezing weather. Remote sensors and alarms may be installed to monitor tower conditions. Do not operate the tower without a heat load. Basin heaters may be used to keep the water in the tower pan at an above-freezing temperature. Heat trace "heating tape" is a resistive heating element that is installed along water pipes to prevent freezing in cold climates. Maintain design water flow rate over the tower fill. Manipulate or reduce airflow to maintain water temperature above freezing point. Such fires can become very intense, due to the high surface-volume ratio of the towers, and fires can be further intensified by natural convection or fan-assisted draft. The resulting damage can be sufficiently severe to require the replacement of the entire cell or tower structure. For this reason, some codes and standards [38] recommend that combustible cooling towers be provided with an automatic fire sprinkler system. Fires can propagate internally within the tower structure when the cell is not in operation such as for maintenance or construction , and even while the tower is in operation, especially those of the induced-draft type, because of the existence of relatively dry areas within the towers. At Ferrybridge power station.

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4: Vapour Line Dia Online Calculation for Juice Heater and Evaporator

www.enganchecubano.com recommended for Evaporation Rate of The Several Vessels of a multiple effect working under the condition of temperature drop from oC to 55oC For General Consideration of evaporation rate taken for calculations.

Inexpensive, slow, low quality, energy intensive Vacuum evaporation multiple effect Good quality, energy efficient, costly equipment Freeze concentration High quality, slow, costly equipment, limited solids attainable Reverse osmosis High quality, slow, costly equipment, limited solids, clear only Electrodialysis High quality, slow, costly equipment, limited solids, clear only Since vacuum concentration strips the natural aroma from the juice, quality suffered. Essence recovery and add back was an improved solution. Although in the absence of recovered essence, juice added back is an effective solution. Water removal as affected by concentration greatly simplifies juice handling, storage and shipping logistics. High Brix is limited by viscosity build up due to the presence of pectin substances and insoluble solids or pulp. In the concentrated and frozen or refrigerated form the juice can be held for extended periods, shipped, or stockpiled for future use. Indeed, the global trade in frozen concentrate has profoundly influenced juice and juice beverage developments, since long term stability and ease of transport make concentrates a readily available commodity. Concentrates must be maintained cool, if not frozen to prevent quality loss primarily Maillard browning type reactions affecting colour and flavour. Three can volumes of water added for reconstitution. Although traditional jelly making relied on the natural pectin present in fruits, commercially standardized pectin is invariably added in commercial operations. The process is related to concentration, as the juice is partially concentrated and sugar is added to increase the solids level to above 65 percent. Combined with pectin and acid and hot filled, jellies are reasonably shelf stable and, along with the pectin derived from certain fruits can be considered a co-product of juice manufacture Chapters 11 and As with other concentration methods, the use of vacuum concentration during boil down and rapid filling and cooling, dramatically increases jelly quality. Quality and efficiency considerations now favour vacuum systems in large throughput operations, although open steam kettles suffice in small niche markets. The key to open kettle jelly manufacture is: Although the combination of low pH, high solids and hot fill eliminates microbial spoilage, an opened container can be recontaminated by sugar-tolerant mould. Also, high temperatures during preparation or subsequent storage reduced quality. Ultimately Maillard darkening and off flavour development occurred. Very delicate fruits make acceptable jelly, but the flavour is far removed from the fresh or gently processed juice product. Low calorie jelly is even more difficult to manufacture and store. Low methoxy pectin and calcium salts or other gel systems that are not dependent upon high sugar level provide adequate gel set. However, such systems are more susceptible to post process contamination and require refrigeration after opening. Indeed, wine was originally spoiled fruit juice that over the millennia was appreciated and perfected long before juices were refined. Actually, the technical and lay literature devoted to wine far exceeds the total treatment of all juices and similar beverages combined. Wine is briefly mentioned here since it represents a high value added product from fruits and also a step in the manufacture of vinegar, a logical by-product of juice manufacture. The biquitous presence of all types of microbes, the sugar and nutrient content of fruits and generally low pH provides an ideal environment for "something" to grow. Airborne, that something will no doubt be mould, with an unsightly mass of mycelia and offensive odours. However, below the surface where oxygen is limited, yeast growth is likely, resulting in the production of ethyl alcohol and carbon dioxide gas. The classic Gay-Lussac equation is an over simplified but stociometrically reasonable depiction of the transformation of fermentable fruit sugars to ethanol and CO2 Figure 8. Wine manufacture is challenging, relatively straightforward and well treated in classic texts Amerine, et al. Many of the steps inherent in juice production also apply to wine, including selection of fruit and attention to quality and sanitation. Fruits do not necessarily have to be peeled, cored, deseeded, pressed, etc. Light coloured fruits are best pressed soon after crushing and treated with about ppm sulphur dioxide to prevent browning. Even here, clarification is not required until after the fermentation, SO2 also serves to inhibit spurious microbial growth, In the case of coloured fruits where pigment extraction into the must unfermented juice properly adjusted for fermentation is desired, the initial phase of fermentation serves to extract colour and soften the crushed material by natural enzyme activity , thus increasing press yield. This is one advantage of wine over juice; by setting the proper conditions and yeast inoculation, fermentation can proceed, thereby preventing microbial spoilage. In addition, the evolving CO2 serves to exclude oxygen and the alcohol build up further limits competing microbes. The type of yeast is important. Special wine strains selected to resist SO2 and efficiently product alcohol and desirable flavours are used. Certain grape cultivars under specific cultivation and climatic conditions are the exception. As with juice, imbalances in must acid or soluble solids are thereby corrected. The adjustments or amelioration depends upon the specific fruit and wine style, In contrast to grape must, many fruits lack the nutrients necessary to sustain yeast growth. Thus yeast nutrients such as yeast extract or diammonium phosphate may be needed up to 0. Crushed fruit is apt to have more yeast nutrients than pressed juice, so addition may be unnecessary in the latter, A vigorous strain of pure wine yeast at about 0. Oxygen early in the fermentation promoted yeast growth, later it is detrimental to wine quality. Ageing can improve certain wines. Whereas most beverage control relates to matters of food safety and fair trade, alcohol controls also serve to produce considerable tax revenue. In addition, the adverse effects of excessive consumption require special sales and consumption scrutiny. These vary by nation and culture, depending if alcohol is viewed as a curse, source of tax revenue or both, There are national standards specifying the amount if any of sugar, acid, water permissible. This defines alcohol strength and limits must manipulation more so than with juice beverages, where low juice levels are permissible, if properly labelled, Alcohol has some preservative effects by acting as an additional hurdle along with low pH. The extreme is fine wine, which may be many decades old. Fruit wines do not share the lofty image of certain fine wine grape cultivars. This is partially due to the several thousand year grape wine tradition, lack of experience with non grape wines and the more difficult manufacturing requirements. Highly acceptable wines can be made from practically all fruits, including exceptional ones in some cases. Indeed, there are some soft fruits from both temperate and tropical regions whose pigment stability and flavour profile match those of any grape wine lacking only intensive research, development and marketing efforts, The most common quality defects of fruit wines are excessive sweetness and oxidized flavour and colour. Practice and attention to detail can easily avoid both. Of course, no food product, including fine aged wine is infinitely stable. Even under ideal storage conditions, deterioration of quality, which is mentioned in Chapter 4, is inevitable. Microbial contamination by lactobacillus can convert malic acid to lactic acid, reducing the acidity and changing the character, sometimes for the better. A more dramatic change is affected by Acetobacter, which can convert wine to vinegar in the presence of air. In fact, the vinegar fermentation is more difficult to initiate and control than wine making. Both products have their place in adding value to fruits. Courtesy Ted Labuza 8. From this diagram the influence of water activity on the various deterioration mechanisms affecting juices is well summarized. As seen from the generalized curves: Microbial growth occurs only very slowly below 0. Additional water molecules protect these sites. At higher moisture levels the above reactions dominate. For comparative purposes, single strength juices have Aws around 0. In the dry state ambient storage is possible, although low temperature still serves to extend storage life. Water is much easier to remove from fluids that can be pumped and manipulated through heat exchange and vapour removal systems. Mass and heat transfer becomes more of a challenge as the juice loses moisture and fluidity. There are a number of dehydration techniques applicable to juices Table 8. For economic reasons most are based on some degree of juice concentration above single strength, generally as high as practical, given the flow characteristic and mechanical properties of the concentrated juice and design features of the dryer.

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5: Pan evaporation | Revolvy

This would heat the juice prior to entry to the first effect of the evaporator set, increasing the heat available in that vessel for evaporation. The proposal was seen to offer a relatively low-cost option to boost evaporator capacity.

Boiling tubes Pre-concentrators Nowadays, falling-film tubular evaporators are mainly used for high capacity concentration in the dairy industry. The complete calandria heating unit is made of stainless steel and divided into a number of sections separate from each other. Depending on the nature of the process, the calandria is divided into 4 â€” 6 sections in a pre-concentrator. The product is pumped to the top end of the first heating section and distributed to its tubes. The volume of the product is reduced by the evaporation of water that takes place during the downflow. At the bottom end of the section, the vapour evolved is removed and the product is collected in a sump. The product is pumped into the next section and back to the top end of the calandria. The heat transfer surfaces of the sections arranged one after the other become smaller and smaller due to the increasing concentration. The compressor fan draws off the vapour from the collector and compresses it. The compressed vapour is forced into the casing of the heater, where it then condenses on the outer surface of the tubes. The condensate is pumped out and used for pre-heating the feed product. Multiple-effect evaporators Multiple-effect evaporators are usually used. The theory is that if two evaporators are connected in series, the second effect can operate at a higher vacuum and therefore at a lower temperature than the first. The vapour evolved from the product in the first effect can be used as the heating medium for the next effect, which operates at a lower boiling temperature due to the higher vacuum. One kilogram of water can be evaporated from a product with a primary steam input of 0. It is also possible to connect several evaporator effects in series to further improve steam economy. However, this makes the equipment more expensive and involves a higher temperature in the first effect. The total volume of product in the evaporator system increases with the number of effects connected in series. This is a drawback in the treatment of heat-sensitive products. However, evaporators with four to seven effects and additional finishers have been used in the dairy industry for a long time now in order to save energy. Thermal vapour recompression TVR The vapour evolved from the product can be compressed and used as a heating medium. This improves the energy balance of the evaporator. A thermocompressor is used for this purpose. Part of the vapour is supplied to the thermo-compressor, to which high-pressure steam â€” 1. The compressor uses the high steam pressure to increase the kinetic energy and the steam is ejected at high speed from the nozzle. This jet effect mixes the steam and the vapour from the product and compresses the mixture to a higher pressure. Using a thermocompressor together with a multiple-effect unit optimizes the energy balance. Process flow The milk is pumped from a balance tank 1 to the pasteurizer 2 , where it is pasteurized and heated to a temperature slightly above the boiling point of the first evaporator effect. The water evaporates and the milk is concentrated as the thin film of milk flows downwards in the tubes. The concentrate is separated from the vapour in the bottom part of the calandria and the vapour separator 5 and pumped to the second effect 6. After further evaporation in the second effect, the concentrate is again separated from the vapour in the bottom part of the calandria and the vapour separator 5 and pumped out of the system for further treatment The injection of high-pressure steam into the thermocompressor 7 increases the pressure of the vapour from the first effect. Evaporation efficiency A two-effect falling-film evaporator with thermocompressor requires about 0. Without the thermocompressor, the specific steam consumption would be approx. Demand for lower energy consumption has led to the development of facilities with more than six effects, but certain limits must be observed in this instance. The greater the number of effects, the lower the temperature difference in each individual effect. Potential temperature differences are also reduced in the form of pressure drops and increased boiling temperatures. This requires larger heat transfer surfaces and results in higher capital costs. Larger heat transfer surfaces then mean greater difficulties in ensuring uniform distribution of the liquid over the heat transfer surfaces. Another disadvantage is the longer residence time of the product in the system. In a six-effect evaporator with thermocompressor, it is possible to evaporate 12 kg of water with 1 kg of steam. This is equivalent to a specific steam consumption of 0. How far the concentration process can be forced is determined by product properties such as viscosity and sensitivity to heat. A five-effect evaporator with thermocompressor needs about 0. Mechanical vapour recompression MVR Fig. Unlike a thermocompressor, a mechanical vapour recompression system fan MVR , draws all the vapour out of the evaporator and compresses it before returning it to the heating side of the evaporator. Increasing the pressure of the vapour requires mechanical energy which drives the compressor. Thus during production, the evaporator requires no additional thermal energy or only very little thermal energy towards the end of a production cycle, apart from for the steam used for heat treatment before the first effect. Thus, there is almost no residual vapour to be condensed. The compressed vapour is returned from the compressor to the pre-concentrator to heat the product. A pasteurizer heated with live steam is installed before the MVR effect in the system. Excess vapour is condensed in a separate condenser. Mechanical vapour recompression makes it possible to evaporate 80 â€” kg of water with 1 kWh. Using an evaporator with mechanical vapour recompression can halve the operating costs compared to a conventional six-effect evaporator with a thermocompressor.

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6: Evaporator - Wikipedia

Scale hampers heat flow by solid layer with low heat conductivity At constant evaporation rate the temperature gradient rises due to scale formation on heating surfaces.

Uses[edit] One kind of evaporator is a kind of radiator coil used in a closed compressor driven circulation of a liquid coolant. The appropriate process can be used to remove water or other liquids from liquid based mixtures. The process of evaporation is widely used to concentrate liquid foods, such as soup or make concentrated milk called "condensed milk" done by evaporating water from the milk. In the concentration process, the goal of evaporation is to vaporize most of the water from a solution which contains the desired product. One of the most important applications of evaporation is in the food and beverage industry. Foods or beverages that need to last for a considerable amount of time or need to have certain consistency, like coffee , go through an evaporation step during processing. In the pharmaceutical industry, the evaporation process is used to eliminate excess moisture, providing an easily handled product and improving product stability. Preservation of long-term activity or stabilization of enzymes in laboratories are greatly assisted by the evaporation process. Another example of evaporation is in the recovery of sodium hydroxide in kraft pulping. Legally, all producers of waste must dispose of waste using methods compatible with environmental guidelines; these methods are costly. By removing moisture through vaporization, industry can greatly reduce the amount of waste product that must be processed. Energetics[edit] Water can be removed from solutions in ways other than evaporation, including membrane processes, liquid-liquid extractions , crystallization , and precipitation. Evaporation can be distinguished from some other drying methods in that the final product of evaporation is a concentrated liquid, not a solid. It is also relatively simple to use and understand since it has been widely used on a large scale, and many techniques are generally well known. In order to concentrate a product by water removal, an auxiliary phase is used which allows for easy transport of the solvent water rather than the solute. Water vapor is used as the auxiliary phase when concentrating non- volatile components, such as proteins and sugars. Heat is added to the solution, and part of the solvent is converted into vapor. Heat is the main tool in evaporation, and the process occurs more readily at high temperature and low pressures. Heat is needed to provide enough energy for the molecules of the solvent to leave the solution and move into the air surrounding the solution. The energy needed can be expressed as an excess thermodynamic potential of the water in the solution. Leading to one of the biggest problems in industrial evaporation, the process requires enough energy to remove the water from the solution and to supply the heat of evaporation. The need to overcome the surface tension of the solution also requires energy. The energy requirement of this process is very high because a phase transition must be caused; the water must go from a liquid to a vapor. When designing evaporators, engineers must quantify the amount of steam needed for every mass unit of water removed when a concentration is given. The heat that needs to be supplied by the condensing steam will approximately equal the heat needed to vaporize the water. Another consideration is the size of the heat exchanger which affects the heat transfer rate. Some common terms for understanding heat transfer: The applied heat converts the water in the solution into vapor. The vapor is removed from the rest of the solution and is condensed while the now-concentrated solution is either fed into a second evaporator or is removed. The evaporator, as a machine, generally consists of four sections. The heating section contains the heating medium, which can vary. Steam is fed into this section. The most common medium consists of parallel tubes but others have plates or coils typically made from copper or aluminium. The concentrating and separating section removes the vapor being produced from the solution. The condenser condenses the separated vapor, then the vacuum or pump provides pressure to increase circulation. Circulation evaporator Natural circulation evaporators are based on the natural circulation of the product caused by the density differences that arise from heating. In an evaporator using tubing, after the water begins to boil , bubbles will rise and cause circulation, facilitating the separation of the liquid and the vapor at the top of the heating tubes. The amount of evaporation that takes place depends on the temperature difference between the steam and the solution. Problems can arise if the tubes are not well-immersed in the solution. If this occurs, the system will be dried out and circulation compromised. In order to avoid this, forced circulation can be used by inserting a pump to increase pressure and circulation. Forced circulation occurs when hydrostatic head prevents boiling at the heating surface. Common uses of forced circulation evaporators include waste streams, crystallizers, viscous fluids, and other difficult process fluids as suppressed boiling can reduce scaling and fouling. Other problems are that the residing time is undefined and the consumption of steam is very high, but at high temperatures, good circulation is easily achieved. Falling film evaporator[edit] Main article: The uniform distribution of the solution is important when using this type of evaporator. The solution enters and gains velocity as it flows downward. This gain in velocity is attributed to the vapor being evolved against the heating medium, which flows downward as well. This evaporator is usually applied to highly viscous solutions, so it is frequently used in the chemical,sugar, food, and fermentation industries. Rising film Long Tube Vertical evaporator[edit] Main article: Rising film evaporator A rising film evaporator In this type of evaporator, boiling takes place inside the tubes, due to heating made usually by steam outside the same. Submergence is therefore not desired; the creation of water vapor bubbles inside the tube creates an ascensional flow enhancing the heat transfer coefficient. This type of evaporator is therefore quite efficient, the disadvantage being to be prone to quick scaling of the internal surface of the tubes. This design is then usually applied to clear, non-salting solutions. Sometimes a small recycle is provided. Sizing this type of evaporator is usually a delicate task, since it requires a precise evaluation of the actual level of the process liquor inside the tubes. Recent applications tend to favor the falling-film pattern rather than rising-film. Climbing and falling-film plate evaporator[edit] Main article: Climbing and Falling Film Plate Evaporator Climbing and falling-film plate evaporators have a relatively large surface area. The plates are usually corrugated and are supported by frame. During evaporation, steam flows through the channels formed by the free spaces between the plates. The steam alternately climbs and falls parallel to the concentrated liquid. The steam follows a co-current, counter-current path in relation to the liquid. The concentrate and the vapor are both fed into the separation stage where the vapor is sent to a condenser. This type of plate evaporator is frequently applied in the dairy and fermentation industries since they have spatial flexibility. A negative point of this type of evaporator is that it is limited in its ability to treat viscous or solid-containing products. There are other types of plate evaporators, which work with only climbing film. Multiple-effect evaporator Unlike single-stage evaporators, these evaporators can be composed of up to seven evaporator stages effects. The energy consumption for single-effect evaporators is very high and is most of the cost for an evaporation system. Putting together evaporators saves heat and thus requires less energy. A heat-saving-percent equation can be used to estimate how much one will save by adding a certain number of effects. The number of effects in a multiple-effect evaporator is usually restricted to seven because after that, the equipment cost approaches the cost savings of the energy-requirement drop. There are two types of feeding that can be used when dealing with multiple-effect evaporators. Forward feeding takes place when the product enters the system through the first effect, which is at the highest temperature. The product is then partially concentrated as some of the water is transformed into vapor and carried away. It is then fed into the second effect which is slightly lower in temperature. The second effect uses the heated vapor created in the first stage as its heat source hence the saving in energy expenditure. The combination of lower temperatures and higher viscosities in subsequent effects provides good conditions for treating heat-sensitive products, such as enzymes and proteins. In this system, an increase in the heating surface area of subsequent effects is required. Another method is using backward feeding. In this process, the dilute products are fed into the last effect which has the lowest temperature and are transferred from effect to effect, with the temperature increasing. The final concentrate is collected in the hottest effect, which provides an advantage in that the product is highly viscous in the last stages, and so the heat transfer is better. Since some years there are also in operation multiple-effect vacuum evaporators with heat pump, well known to be energetically and technically more effective than systems with mechanical vapor recompression MVR because due to the lower boiling temperature they can handle highly corrosive liquids or which may form incrustations. Agitated thin film evaporators Agitated thin-film evaporation has been very successful with difficult-to-handle products. Simply stated, the method quickly separates the volatile from the less volatile components using indirect heat transfer and mechanical agitation of the flowing product film under controlled conditions. Some evaporators are sensitive to differences in viscosity and consistency of the dilute solution. These evaporators could work inefficiently because of a loss of circulation. The pump of an evaporator may need to be changed if the evaporator needs to be used to concentrate a highly viscous solution. Fouling also occurs when hard deposits form on the surfaces of the heating mediums in the evaporators. In foods, proteins and polysaccharides can create such deposits that reduce the efficiency of heat transfer. Foaming can also create a problem since dealing with the excess foam can be costly in time and efficiency. Antifoam agents are to be used, but only a few can be used when food is being processed. Corrosion can also occur when acidic solutions such as citrus juices are concentrated. The surface damage caused can shorten the long-life of evaporators. Quality and flavor of food can also suffer during evaporation. Overall, when choosing an evaporator, the qualities of the product solution need to be taken into careful consideration. Evaporator marine Large ships usually carry evaporating plants to produce fresh water, thus reducing their reliance on shore-based supplies. Steam ships must be able to produce high-quality distillate in order to maintain boiler-water levels. Diesel-engined ships often utilise waste heat as an energy source for producing fresh water.

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Evaporator design consists of three principal elements: heat transfer, vapor-liquid separation, and efficient utilization of energy. In our sugar industry the solvent is juice, heat is supplied by condensing steam, and the heat is transferred by indirect heat transfer across metallic surfaces.

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used to evaluate the cost of the steam consumed by the factory and the optimaldesign of the evaporation system as well as the juice and syrup heaters network. Key-words: sugar production, thermoeconomicoptimization,heat recovery.

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