How green is my orange biology essay

Design

Many fruits and veggies contain indispensable oils, which are H2O repellant or hydrophobic liquids that give the fruit or vegetable its typical aroma. These indispensable oils are frequently extracted for usage in aroma, cosmetics, nutrient, medical specialty and house cleansing merchandises. Many of these indispensable oils are extracted through liquid chemical extraction utilizing unsafe chemical dissolvers, such as methylene chloride.

Conventional methods used to pull out indispensable oils include steam distillment or liquid chemical extraction. Steam distillment requires high energy input as energy is required to boil H2O to bring forth steam. The energy used combined with the dangers of heating big sums of affair on an industrial degree means that this procedure does non adhere to the rules of green chemical science. This is an of import constituent of learning pupils about green chemical science as Green Chemistry is non merely a construct used in the lab but a construct meant to be used on an industrial graduated table to do merchandises which are utile to the universe.

Steam distillment may look like a benign procedure until it is evaluated against the 12 rules on an industrial graduated table. Scientists have discovered the usage of supercritical C dioxide (CO2) at high force per unit area is an alternate method of pull outing indispensable oils and that is the procedure which you will detect with your pupils through this activity. It is of import to observe that the usage of supercritical CO2 for extraction does non impact the net sum of CO2 in the environment, therefore utilizing supercritical CO2 for indispensable oil extraction is non considered to impact clime alteration in any manner. Alternatively, the usage of supercritical CO2 is considered a greenish manner of indispensable oil extraction since it

reduces the sum of energy input and eliminates the demand for unsafe dissolvers. Because supercritical CO2 does non hold high responsiveness with indispensable oils, which can take to the dislocation of the indispensable oil, its usage in indispensable oil extraction is deriving popularity.

Currently, supercritical CO2 is used to take caffeine from java beans to bring forth decaffeinated java and as a replacing for perchloroethlyene in dry cleansing applications. In this experiment, pupils will pull out the indispensable oil d-limonene from the rind (skin) of orange Peels utilizing both a steam distillment or simple distillment method and the method of utilizing supercritical CO2. They will analyse the difference between the two methods and do connexions between the research lab activities they do in the schoolroom and the industrial chemical procedures that are used to do merchandises. D-limonene gives oranges, lemons and limes their citrus-like aroma.

Please refer to extra instructor background info and safety considerations at the terminal of this lesson.

* The steam distillment as a demo lab and the supercritical CO2 as a custodies on pupils lab if you feel that you merely have one category period to cover this stuff.

Educational Goal: To understand chemical, steam and CO2 extraction methods and their relationship to green and industrial chemical science patterns. Student Aims: Students will …Extract indispensable oils from oranges utilizing steam distillmentExtract indispensable oils from oranges utilizing supercritical CO2Calculate the usage of energy in both extractions.

Compare the usage of energy in both extractionsCompare the usage of risky chemicals in both extractionsLearn about stage alterations of CO2

Materials: (per lab group -3 pupils)

Steam Distillation

Watt ' s up metre (optional)OrangeFood graterScaleWeigh boat or weigh paperSpatulaDe-ionized H2O (DI H2O)Distillation setup2 pealing bases with clinchsHeat beginning (i. e. hot home base, bunsen burner)Condensing flaskCapacitorJoint arrangersThermometerCollection beaker or flaskCold H2O beginningTubing

CO2 Extraction

3 braces of baseball mitts2 oranges1 spiral trap (copper wire cyberspace to incorporate the orange Peel) (18-22 gage Cu or aluminium wire set into a tapering spiral form, wire can be found at humanistic disciplines and trades shops)1 zester or orange Peel grater -medium classtwo weighing boatsone spatulaone brace of forceps5 ten 15 mL polypropene extractor tubings with caps (Corning Catalog # 430052)1 crystalline polycarbonate plastic cylinder on base (a plastic sodium carbonate bottle works all right)An 8 inch H2O bath heated to 65oC20 oC to 100oC intoxicant thermometer1 lb dry ice crushed dry iceanalytical balanceTime Required: 2 x 60 infinitesimal category periodNational Standards Met: National: S1, S2, S5, S6MA Standards: C1, C6Green Chemistry Principles Addressed: 5, 6, 11, 12

Teacher Homework:

Crush the dry ice into a all right pulverizationYou may desire to allow pupils make this portion but if you want to fix these before category, follow the

waies below: Prepare spiral traps prior to the lesson (you can hold the pupils do this measure if you feel that you have adequate category clip) – one per pupils following the waies belowCut the 18-22 gage Cu wire into 10 inch long pieces.

Coil the piece of Cu wire around so the it creates a bowl-like construction that will suit into the underside of the trial tubing and supply a backstop for the orange Peel once it is inserted into the trial tubing. Replace the trial tubing cap. Prepare 3-4 big beakers of H2O and heat to 50-60 grades at the forepart of the category.

Procedure:

Day 1

Show the PowerPoint Slides 1-5 for this lesson to give the background information to the pupils. Explain to the pupils that they will now pull out orange oil, limonene from an orange utilizing steam distillment. Hand out the pupil lab sheet and have the pupils review the information. Check for understanding and reply any inquiries. Instruct the pupils to get down the lab activity for steam distillment. When all pupils have finished debrief the pupils data sheet inquiries, paying particular attending to the analysis of the procedure against the 12 rules of green chemical science.

Day 2

Optional: frock up every bit Supercritical CO2 miss for the twenty-four hours!

Review indispensable oil extraction from the last category period. Now show PowerPoint slides 5 – 9Instruct the pupils to get down the 2nd portion of the

lab. During the lab, supervise the H2O to guarantee a changeless temperature. When pupils are ready transfer the 50EsC-60EsC H2O from the beaker on the hot home base into the polycarbonate plastic bottle. Fill the H2O up to 2/3 of the bottle. Add more H2O to the beaker on the hot home base, and maintain the temperature of that H2O to 50-60EsC.

Have pupils stand at least a pes off from the experiment after they have dropped their trial tubing into the H2O and have them watch from the side as tops can sometimes start off due to force per unit area. After the lab is complete have the pupils fill out the pupil lab sheet. Show Powerpoint slide # 10Hand out the 12 rules comparison pupil tabular array.

Have pupils work in groups to finish the tabular array and so discourse their replies as a category. This lesson program was based on a laboratory experiment McKenzie, Lallie C. ; Thompson, John E. ; Sullivan, Randy ; Hutchison, James E. Green chemical processing in the instruction research lab: a convenient liquid CO2 extraction of natural merchandises.

Green Chemistry (2004) , 6 (8) , 355-358.

Steam Distillation Orange Oil Extraction

Student Lab Procedure

Many fruits and veggies contain indispensable oils, which are H2O repellant or hydrophobic liquids that give the fruit or vegetable its typical aroma. These indispensable oils are frequently extracted for usage in aroma, cosmetics, nutrient, medical specialty and house cleansing merchandises. You will utilize the lab waies below to pull out indispensable oils from an

orange utilizing steam distillment. This indispensable oil is called d-limonene and is represented by the chemical construction shown below: Chemical construction of d-limonene

Steam Distillation:

Steam distillment is a technique used to insulate or pull out compounds at temperatures below their boiling points. Some compounds, such as indispensable oils, tend to break up at their boiling temperature. By adding H2O or steam to the compound, the boiling point of the compound is reduced, leting it to vaporize at a lower temperature so as to avoid decomposition during extraction. The evaporated compounds are in their gaseous stage one time heated, but condense back into their liquid stage upon contact with a cold surface (such as a capacitor with cold H2O environing it) .

The compound in liquid signifier is so collected into a receiving flask. The diagram below shows the distillment set-up.

Procedure:

1. Roll up the undermentioned setup from the supply country: OrangeFood graterWatt ‘ s Up Meter (optional)ScaleWeigh boat or weigh paperSpatulaDeionized H2O (DI H2O)Distillation setup2 pealing bases with clinchs1 hot home baseCondensing flaskCapacitorJoint arrangersThermometerCollection beaker or flaskCold H2O beginningTubingReview the informations sheet below to guarantee that youa rhenium entering informations at certain stages of the experiment.

Set up the distillment equipment as shown in the diagram attaching the Watt ‘ s Up Meter to the hot home base. Determine the mass of the receiving flask and record it on the pupil informations sheet. Use the grater at the medium grating side to grate off the outside Peel of the orange. Topographic point 25 g of the orange rind in the distilling flask. Add 25 mL DI H2O into the distilling flask. Topographic point the condensing flask in an oil bath over a hot home base. Bend on the hot home base and let the flask to heat up. Monitor the temperature at which the H2O in the distilling flask begins to boil.

Roll up the indispensable oil distillation in the receiving flask. Allow the contents in the distilling flask to boil until about 20 milliliter of the distillation is collected. Determine the mass of the indispensable oil collected. Calculate the per centum recovery of the indispensable oil compared to the mass of the rind. Complete the pupil informations sheet for steam distillment and reply all inquiries in full.

Supercritical CO2 Orange Oil Extraction

Student Lab Procedure

Scientists have discovered the usage of supercritical C dioxide (CO2) at high force per unit area as an alternate method of pull outing indispensable oils.

CO2 is the gas exhaled by worlds during respiration, is consumed by workss during photosynthesis and exists in the environment in copiousness from human activity such as fossil fuel burning. Supercritical CO2 is considered an alternate manner of indispensable oil extraction. Because supercritical CO2

does non hold high responsiveness with indispensable oils, which can take to the dislocation of the indispensable oil, its usage in indispensable oil extraction is deriving popularity. Currently, supercritical CO2 is used to take caffeine from java beans to bring forth decaffeinated java and as replacing for perchloroethlyene in dry cleansing applications.

Procedure:

Roll up the undermentioned setup from the supply country: 1 OrangeSafety spectaclessBaseball gloves (latex or cyanide)Hot pads/oven mitt for managing dry iceFood graterWeigh boatSpatulaScale or ternary beam balanceForcepss or pincers1 trial tubing full of crushed dry ice (you will travel and acquire this when you are ready for this measure)1 solid trap18-22 gage Cu wire15 mL polypropene extractor tubings with caps (one per individual in your group)500 ml plastic cylinder500 milliliter beakerPut on safety baseball mitts and spectacless. Using the medium grating gap on a nutrient grater, grating merely the coloured portion of the orange Peel. Using the graduated table, spatula and boat, step 2.

5 g of orange Peel and put it aside. Find the mass of the extractor tubing and cap and record it on the pupils data sheetRefer to the Tube Preparation page for images of the spiral and the undermentioned stairss. Take the piece of Cu wire and make a trap for the orange Peel as shown in the image below: Fix a trap to keep the orange rind in by obtaining Cu wire and organizing 5-6 tight spirals around the underside of the tubing. Keep one terminal of the wire against the narrow terminal of the tubing while wrapping and organizing the 5-6 tight spirals. The wire will necessitate to suit into the tapering terminal of the extractor tubing. At the really bottom, the diameter of the spiral is

smallest, and bit by bit enlarges to the same interior diameter of the largest portion of the extractor tubing by the 5-6th spiral. Leave a long terminal of the wire available as a root.

Put the trap into the extractor tubing with the tapering terminal in first. The long root of the trap should sit merely below the rim of the extractor tubing. Topographic point 2. 5 g of orange Peel into the tubing so that it sits on the coiled portion of the trap. Tap the underside of the tubing against the lab bench to guarantee all orange Peel is off of walls. Very of import: make non pack the orange Peel in tightly. Wear the cryogenic baseball mitts (these baseball mitts should be worn every clip dry ice is handled) .

Using a howitzer and stamp or a cock, crush the dry ice into little pieces. The smaller the pieces, the better. Use right off or the dry ice will sublimate (thaw) . Fill the extractor tubing with crushed dry ice all the manner to the top.

Tap the underside of the tubing against the lab bench to pack as much dry ice in as possible. Topographic point the cap on the extractor tubing. Tighten the cap, but do non over tighten so that you over screw the cap and travel from tight to free. Transfer the tubing to the prewarmed pastic bottle at the forepart of the category that is being monitored by your instructor.

STAND BACK FROM THE EXPERIMENT AS TOPS CAN POP OFF.

Allow the extractor tubing to sit in the bottle.

You may hear the sissing sound of CO2 gas escaping, which is expected. When the degree of dry ice (solid CO2) has lowered, intending the solid CO2 has been converted to gaseous and liquid CO2, take the tubing from the H2O and easy uncap it. Always indicate the tubing off from your face and organic structure. Add more crushed dry ice a few times until you can see a liquid at the bottom tip of the extractor tubing.

This pale xanthous liquid is the indispensable oil d-limonene. The xanthous oil should be in the tip of the tubing when the extraction is complete. Carefully take the trap by drawing the Cu root with pincers. If any solid remains in the tubing, take it with a spatula. Note: Keep the tubing upright to avoid any loss of the oil. There should be nil in the tubing at this point except for the indispensable oil collected in the tip of the tubing.

Dry the exterior of the tubing with a paper towel, weigh the tubing, and find the mass of the merchandise. Calculate per centum recovery based upon the output of the merchandise compared to the mass of rind used.

Tube Preparation

Loosely pack the tubing with 2. 5 g orange rind

Tube with Cu trap inserted

Trap: Cu wire with tapered coiled terminal

Tube with

cap removed

Dry, empty clean extractor tubing (15 milliliters polypropene with a screw cap)

Pack the remainder of the tubing with crushed dry iceTopographic point the tubing in the plastic container (which is filled 2/3 of the manner with 50EsC – 60EsC H2O) . Always point the tubing off from the face and organic structure to avoid hurt. Tightly screw the cap on the tubing

How Green is my Orange

Student Data Sheet – Steam Distillation

What is the mass of the prohibitionist, empty having flask? _____gramsWhat is the mass of having flask with indispensable oil distillation? _____gramsWhat is the mass of the indispensable oil collected? _____gramsWhat is the volume of the indispensable oil collected? _____mLWhat is the mass of the orange rind placed into condensing flask? _____gramsWhat is the temperature at which the H2O in the distilling flask furuncles? _____EsCWhat is the colour of the indispensable oil you have created? _____What was the percent recovery of the indispensable oil compared to the mass of the rind used with the steam

distillment extraction? To cipher the per centum recovery:(mass of indispensable oil/mass of rind) x 100

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How many proceedingss does it take to roll up about 20 milliliter of the distillation?

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In a brief paragraph, see the belongingss of the indispensable oil you have created – paying particular attending to the toxicity and impact on the environment of the d-limonene.

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In a brief paragraph, analyze this procedure against the 12 rules of green chemical science. Which principles does this procedure non adhere to and why?

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Pull the chemical construction of the D-limonene you have created below:

How Green is My Orange

Student Data Sheet – Supercritical Carbon dioxide

What is the mass of the indispensable oil collected?

_____gramsWhat is the volume of the indispensable oil collected? _____mLWhat is the mass of the orange rind placed into condensing flask? _____gramsWhat is the temperature of the H2O used in the procedure? _____EsCWhat is the colour of the indispensable oil you have created? _____What was the percent recovery of the indispensable oil compared to the mass of the rind used with the steam distillment extraction? To cipher the per centum recovery:(mass of indispensable oil/mass of rind) x 100

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How many proceedingss does it take to roll up about 20 milliliter of the distillation? In a brief paragraph, see the belongingss of the indispensable oil you have created – paying particular attending to the toxicity and impact on the environment of the d-limonene.

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Comparison of Orange Oil Extraction Methods

Not all rules will use to this procedure – put N/A (non applicable) in any cells that do non use to this procedure. REMEMBER: believe about all of these procedures both on a laboratory degree and as an industrial procedure where big measures of merchandise demand to be produced. Use: the information that you gathered utilizing the research lab informations sheets to inform your determination on this grid.

PrincipleTraditional Solvent ExtractionSteam Distillation ExtractionSupercritical CO2 extraction# 1 Pollution bar# 2 Atom Economy# 3 Less risky synthesis# 4 Design safer chemicals# 5 Safer dissolvers and auxilaries# 6 Energy efficiency# 7 Renewable feedstocks# 8 Reduce

Derived functions# 9 Cataylsis# 10 Design for debasement# 11 Real-time analysis# 12 Accident bar

Additional Teacher Background Information and Safety Considerations

Safety concerns

The most serious safety concerns in this experiment affect the possibilities of cap discharge (most common happening) or vessel rupture (seldom observed) . During the proving stage of this experiment, caps blew off during about 4 % of the extractions. All caps were directed upward by the containment cylinders. Caps remained on during all extractions when pupils 1) tightened the cap every bit tightly as possible and 2) did non utilize caps that were stripped. If the cap can non be wholly tightened and continues to turn, the stripped cap should be discarded and replaced. Due to fluctuations in the extractor tubings and caps, a tight seal is non ever formed at their junction. In this instance, the CO2 does non liquefy, and retightening of the cap or replacing of the cap or tubing may be required. Although many alterations of the sealing procedure have been proposed, such as the usage of Teflon tape or parafilm on the togss, it is of import that the cap seal good plenty to bring on liquefaction but non so tightly that the gas can non get away.

The cap must let the gaseous CO2 to get away easy during the extraction and besides must work as a safety valve. During experiment development, efforts were made to detect the passage from the liquid to the solid stage by opening the cap while the CO2 was liquid. In two of these instances, the extractor tubing ruptured, and plastic sherds were propelled several pess

from the demonstrator. Although no hurts occurred, it is recommended that the tubing ever remain in containment cylinders during liquefaction. It is of import to observe that in our experience vas rupture merely occurred while trying to let go of the force per unit area from the vas when liquid CO2 was present.

Industrial methods for obtaining D-limonene.

Traditionally indispensable oils have been extracted through the usage of steam distillment or organic solvent extraction.

During the past two decennaries, great paces have been made in engineering that uses supercritical or liquid C dioxide in topographic point of organic dissolvers. Carbon dioxide (CO2) is utile as a green alternate dissolver because it provides environmental and safety advantages ; it is nonflammable, comparatively atoxic, readily available, and environmentally benign. Processing with CO2 besides consequences in minimum liability in the event of unwilled release or residuary dissolver in the merchandise.

Although CO2 is a nursery gas, when used as a dissolver it is captured from the ambiance, non generated, ensuing in no net environmental injury. Large-scale CO2 processing has had commercial success in many separation and extraction procedures. The tunable solubility belongingss, low toxicity, and easiness of remotion of CO2 have led to good set up CO2 engineering for the extraction of assorted nutrient merchandises, including indispensable oils and hops, and for the decaffeination of java and tea. Another major benefit of utilizing C dioxide as a dissolver is its accessible stage alterations. Unlike other gases, comparatively low temperatures and force per unit areas can be

used to organize liquid and supercritical CO2. As shown on the stage diagram in Figure 2, CO2 sublimes (goes straight from a solid to a gas) at normal atmospheric force per unit area of 1.

01 saloon. The ternary point of CO2, where solid, liquid, and gas stages coexist in equilibrium, is achieved at 5. 2 saloon and -56. 6 C. At or near this point, dry ice thaws, organizing liquid C dioxide.

If the temperature and force per unit area are increased to the critical point (73. 8 saloon and 31. 0 C) , the CO2 exists as a supercritical fluid and has no distinguishable liquid or vapor stage but belongingss that are similar to both.