

The Saponification Reaction





Context & Background

- The basis of the work is that we were challenged to create a solution to an open-ended problem, in this case it was to create hard soap while using different engineering tools and collaborating with an unknown group of individuals.
- While using different tools such as Microsoft Excel to create different soap properties that would be able to sell to consumers at a soap symposium at the end of the term.
- The saponification process is how soap becomes soap. Its process involves the reaction of animal fats or vegetable oils with sodium hydroxide or potassium hydroxide to produce glycerol and sodium salts which is soap.

Design Criteria & Constraints



Our goal for the soap was to something fragrant with conditioning and a nice bubbly lather



Materials were selected carefully so that they wouldn't interfere with the saponification process and the safety of the costumers. For example: peppermint essential oil and blue mica powder both didn't affect the saponification reaction and are safe on skin.



Cold process works best for hard soap, uses less energy and is safer for beginners



To maintain cost-efficiency, we limited our main oils to those prov

Ingredients & Selection

We used the following ingredients:

- Crisco: 224.74 grams (26%)
 - Used to help build up conditioning factor.
- Coconut Oil: 129.88 grams (45%)
 - Used for hardness, cleansing, and bubbly lather properties.
- Olive Oil: 145.38 grams (29%)
 - Used to help build up conditioning factor.
- Peppermint Essential Oil: 14.1g/500g oil
 - Used for a wintery fragrance!
- Micah powder: 4.63 grams/500g oil
 - Used to create a two-tones marble swirl in our soap's design.

Our soap has the following properties:

- Conditioning
- Bubbly Lather
- Cleansing
- Medium Hardness
- Winter Scent & Feel

Mold Selection



Our Mold: a clean, recycled Pringles can



A circular mold helped us achieve our desired marble design and created a soap block that was simple to unmold and slice!



A circular mold facilitated pouring liquid soap and was easy to transport.

Packaging

Goal: simple, eco-friendly, and eyecatching!

Our soap is wrapped in a coffee filter and labelled on the back and front with our gorgeous personal design!

The packaging is cheap (made from paper) and does not substantially add to cost of soap.

Green Chemistry



Our packaging is made from paper and hence is recyclable!



Our soap was produced by the cold process which uses less energy than a hot process and is safer for beginners.



Our soap is made from all-natural ingredients!

Soap Optimizer																			
				Oil Properties							Contribution to Overall Soap Properties								
Oils	Percentage	Quantity (g)	SAP (NaOH)	SAP (KOH)	Hardness	Cleansing	Bubbly Lather	Creamy Lather	Conditionning	Density	Cost	SAP (NaOH)	SAP (KOH)	Hardness	Cleansing	Bubbly Lather	Creamy Lather	Conditionning	Cost
Coconut Oil, 76 deg	21%	107.1063301	0.183	0.257	79	67	67	12	10	0.92	1.63	19.6004584	27.52632683	16.9228001	14.3522482	14.35224823	2.570551922	2.142126601	\$ 1.90
Ghee, any bovine	32%	159.1267573	0.162	0.227	55	15	5 15	i 40	22	1.01	1.67	25.77853468	36.12177391	17.5039433	4.77380272	4.773802719	12.73014058	7.001577322	\$ 2.63
Crisco, old	47%	235.5496154	0.137	0.192	26	C) 0	26	70	0.81	0.42	32.27029731	45.22552615	12.24858	0	0	12.24858	32.97694615	\$ 1.22
Avocado Oil	2%	9.418238851	0.133	0.186	22	C) 0) 22	70	0.92	1.86	1.252625767	1.751792426	0.41440251	. 0	0	0.414402509	1.318553439	\$ 0.19
Olive Oil	31%	153.0162069	0.135	0.19	17	C	0) 17	82	0.92	0.6	20.65718794	29.07307932	5.20255104	0	0	5.202551036	25.09465794	\$ 1.00
Sesame Oil	0%	0	0.134	0.188	15	C) 0) 15	83	0.92	1.77	0	0	0	0	0	0	0	\$ -
Corn Oil	0%	0	0.137	0.192	14	C) 0) 14	84	0.92	0.27	0	0	0	0	0	0	0	\$ -
Grapeseed Oil	0%	0	0.129	0.181	12	C	0 0) 12	88	0.92	0.86	0	0	0	0	0	0	0	\$ -
Sunflower Oil	0%	0	0.135	0.189	11	C) 0) 11	87	0.92	0.28	0	0	0	0	0	0	0	\$ -
Canola Oil	0%	0	0.133	0.186	6	C	0 0) 6	91	0.92	0.21	0	0	0	0	0	0	0	\$ -
Total	100%	500																	
											Mass of Oils (g)	500		Mas	s of NaOH (g)	94.58			
									Percentag	Percentage of Water as a Percentage of Oil		38%		Mass of KOH (g)		132.71			
										Mass of Water (g		190		Total Mass of Lye (g)		227.29			
												Mass of NaOH (g)	Mass of KOH (g)	Hardness	Cleansing	Bubbly Lather	Creamy Lather	Conditionning	Cost
											Totals	100	140	52	19	19	33	69	\$ 6.94
												Recor	nmended Ranges	29-54	12-22	14-46	16-48	44-69	
													Targets	50	20	15	45	65	
												0	bjective Function	4.00E+02					

Soap Calculator - Original Idea of Soap

Options and Iterations

Originally, we aimed for a soap that was very high in conditioning and creamy lather but realized that the cost might have been too high, leading us to altering our formula for a lower costing soap with similar properties.

Soap Calculator vs As Made

- Our total mass of soap wasn't 500g and we gave some to Prof Aucoin for assessment
- Our soap calculator calculated the mass of the soap to a long string of decimals but the scale we were offered only rounded to one decimal place.
- The properties of the soap should closely resemble that of the Soap Calculator as we were accurate to one decimal place for the measurements

Materials	Cost					
NaOH	\$2.22					
Essential Oils (Fragrance)	\$5.00					
Oils	\$4.41					
Micah Powder	\$1.03					
Packaging/Slice of Soap	\$0.42					
Manufacturing Cost/Slice of Soap	\$1.57					
Manufacturing Cost/gram of Soap	\$0.09					
Price of Soap	\$3.50					

Economics

• We broke down our costs by dividing the amount of materials we used by their cost/100g