NANDU NAI LEARNING

Cosmetic Formulation

A bench textbook for salon staff

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English

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This book is a bench text for salon staff who mix, test and sell cosmetic products. It teaches the arithmetic of percent w/w, the four phases, emulsifier and surfactant systems, preservation, actives, pH, stability, packaging and the claims a cosmetic may make. It is teaching, not a licence to sell. Every dose in these pages is a starting point that must be checked against the supplier technical sheet and the rules of the market where the product will be sold. The formulas are examples for learning, and each one closes at 100.00 so the arithmetic can be followed line by line. Nothing here is medical advice, and no formula in this book contains a steroid, hydroquinone, mercury or tretinoin. Read the chapter, weigh the example, write the record, and test before you promise anything or sell anything.

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CHAPTER 1

Percent w/w: the grammar of a formula

Why weight, not volume

A cosmetic formula is a list of weights that share one basis. When a sheet says glycerin 4.00 percent, it means 4.00 grams of glycerin in every 100.00 grams of finished product, not 4.00 millilitres in 100 millilitres of liquid. The difference matters because oils, glycols, alcohols and water do not weigh the same per millilitre, and their density shifts as the bench warms or cools. A recipe written in millilitres quietly changes its composition whenever a supplier changes the grade of an oil. A recipe written in grams does not. Percent w/w, weight by weight, is the basis that labels, batch records and regulators expect, and it is the only basis on which a small line such as a preservative can be discussed honestly.

The basis is 100.00, and every line must add to it. Water is usually written as water to 100, or q.s. to 100, which means water fills whatever the other lines leave. That single convention absorbs small changes without rewriting the whole sheet: raise the preservative by 0.10 and water falls by 0.10. It also exposes arithmetic errors quickly, because a sheet that totals 99.20 or 100.80 is telling you that a line was dropped or counted twice. A formula that does not close at 100.00 is a draft, not a working document. Nobody should weigh from a draft. A formula that closes at 100.00 has passed its first check, and it has passed it before a single gram is on the scale.

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The balance decides how honest the decimal places are. A scale that reads 0.1 g cannot weigh 0.08 g of anything; it can only round, and rounding a preservative or a dye is not a small matter. Choose the balance by the smallest line in the batch, not by the batch size. A 0.10 percent line in a 100 g batch is 0.10 g, which needs a balance reading 0.01 g. A 0.10 percent line in a 1000 g batch is 1.00 g, which the coarser balance can handle. When the smallest line is below the readability of the scale, make a stock solution, weigh the solution, and state the strength on the card.

Write the basis on every page. A percent without a stated basis is a number without a meaning, and the same figure can describe a weight fraction, a volume fraction, or a fraction of the active matter inside a raw material. The bench master should carry the version date, the batch size, the basis, the phase of each line, and the name of the person who approved it. When a client asks why a cream feels different after a supplier change, the version history answers faster than memory. Percent w/w is not red tape; it is the grammar that lets two people make the same product on different days.

- 1. State the basis first: percent w/w means grams per 100.00 grams of finished product.
- 2. List every raw material by INCI name with its as-supplied strength beside it.
- 3. Enter the percent for each line, two decimals for small lines, and never a range.
- 4. Add the lines without water and subtract that total from 100.00 to get the water line.

- 5. Check that the full column, water included, totals 100.00 before any weighing starts.
- 6. Pick the balance by the smallest line, and make a stock solution if that line is too small.
- 7. Scale to the batch with grams equal to batch grams times percent divided by 100.
- 8. Print the batch size, the factor and the version date on the sheet you carry to the bench.

> **Bench example: scaling a 100 g lotion sheet to 250 g**
>
> A 100 g lotion sheet reads water to 100 at 77.20; glycerin 5.00; xanthan gum 0.20; phenoxyethanol 0.80; all remaining lines together 16.80. The lines close at 100.00. Multiply every number by 2.5 for a 250 g batch. Water becomes 193.00 g, glycerin 12.50 g, xanthan 0.50 g, phenoxyethanol 2.00 g, and the remaining lines 42.00 g. Check the new column: 193.00 plus 12.50 plus 0.50 plus 2.00 plus 42.00 equals 250.00 g. Weigh xanthan and phenoxyethanol on the 0.01 g balance, the oils on the 0.1 g balance, and water last, so a small overshoot can be trimmed against the water line rather than against an active. Record the factor, the batch number, and the weight of every line before heating. If the final total reads 249.60 g, the missing 0.40 g is water, not a mystery, and it belongs in the record as a correction. Weigh the water into a vessel large enough for the whole batch, and mark the fill level before heating so a boil-over is visible early. If the sheet is later revised, the factor changes but the percent column does not, which is why the two are kept apart on the page.

CAUTION

Never top up a batch by eye and call it water to 100. Weigh the correction and write it down.

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Reading a formula sheet

A formula sheet is read in phases, not as a shopping list. Phase A holds the water-soluble lines: water, glycerin, chelating agents, some gums and salts. Phase B holds the oil-soluble lines: oils, butters, waxes, emulsifiers and fatty alcohols. Phase C is the cool-down group, where preservatives, fragrance and heat-sensitive actives belong. Phase D is the adjustment: pH, salt for viscosity, or a small premix. Each line should carry an INCI name and, where it matters, the as-supplied strength. A trade name alone is not enough, because two suppliers can sell the same trade name at different concentrations and different pH windows.

The numbers also carry a meaning that is easy to miss. A line written as Sodium Laureth Sulfate 70 percent is not 70 percent active matter in the finished product; it is the strength of the raw material. A line written as water to 100 is a remainder, not a weighed target. A line written q.s. means add enough to reach the stated value, usually a pH. A line written as citric acid, 10 percent solution, means the weight of the solution, not the weight of the acid inside it. Read the version date at the top before you trust any figure, and read the notes under the table, because that is where the supplier dose and the temperature limit usually live.

Phase labels tell you the order of work, and order explains most failures. A gum added dry to water forms lumps that will not dissolve later. An emulsifier added to a cold oil phase leaves wax specks in the cream. A preservative added to a hot batch can flash off and leave the product underdosed while

the sheet still reads correctly. None of these faults are visible on the paper, which is why the phase column deserves as much attention as the percent column. If a sheet has no phase column, group the lines yourself and write the groups on your copy before you start.

Finally, mark the copy you use as the bench master and keep it with the batch record. A sheet that lives in three phones and two notebooks is not controlled, and the version that gets weighed is whichever one someone opened first. When a formula is revised, give it a new number, date it, and retire the old copy rather than editing it in place. Old batches then remain traceable to the sheet that made them. This is the difference between a workshop that can repeat a good result and one that can only remember it. A retired sheet stays in the file, marked superseded, because the batch it made may still be on a shelf.

- 1. Read the version date and the batch size before any other number on the page.
- 2. Check that every line carries an INCI name rather than a marketing name.
- 3. Read the as-supplied strength of pastes, solutions and blends, and write it beside the weight.
- 4. Sort each line into phase A, B, C or D and confirm the phase makes chemical sense.
- 5. Find the water to 100 line and treat it as a remainder, never as a fixed weight.
- 6. Check that the percent column totals 100.00 including water and any q.s. adjustment.
- 7. Read the notes under the table for supplier dose, temperature limit and grade.
- 8. Mark your printed copy as the bench master, date it, and file it with the batch record.

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> **Bench example: reading two similar sheets**
>
> Sheet one lists Sodium Laureth Sulfate 70 percent paste at 14.30 g and water to 100. Sheet two lists a diluted Sodium Laureth Sulfate at 20.00 g and water to 100. Both can make a shampoo, but they do not carry the same active matter. In sheet one the paste contributes 14.30 times 0.70, which is 10.01 g of anionic active in a 100 g batch. In sheet two the diluted raw material might be 28 percent active, which gives 5.60 g, or it might be 50 percent, which gives 10.00 g. The name is similar; the number that matters is different. If you copy the weight from one sheet to the other without reading the strength, the finished shampoo will be either harsh or thin, and the pH and salt curve will behave differently as well. Write the strength beside the weight on your own copy. If neither sheet states a strength, ask the supplier for the technical data sheet before weighing, because a guess here is a batch wasted rather than a lesson learned. Keep both sheets side by side for the comparison, and note on the batch record which one you actually used.

CAUTION

Never substitute a raw material at the same weight when its as-supplied strength differs. Recalculate the line and let water absorb the change.

Grams for a batch

The arithmetic is one multiplication per line. Grams to weigh equals batch size in grams multiplied by the percent on the sheet, divided by 100. For a 400 g batch, a 4.00 percent line needs 16.00 g. The

same factor applies to every line, so a 100 g sheet can be scaled by four to make 400 g. Write the calculated weight beside the percent before you start, not during weighing, because the bench is a poor place to do division. At the end, add the calculated weights; the sum should equal the batch size exactly, and any difference is a mistake to find rather than a rounding to ignore.

Process loss is real and belongs in the record. Some product stays on the mixer, some stays in the beaker, and some is lost to the filling line. A 500 g batch may yield 492 g of filled product. That is a yield figure, not a reason to add water. If the batch is short because a line was under-weighed, the product is not the formula any more; if it is short because of hold-up, the formula is intact and the yield is lower. Recording both numbers, theoretical and actual, keeps the two reasons apart. A batch that is outside the agreed tolerance is a deviation and needs a note, not a quiet stir.

Small batches are harder than large ones for one reason: the small lines. A 50 g batch with a 0.20 percent preservative needs 0.10 g, which is at the edge of a 0.01 g balance and beyond a kitchen scale. Rather than guessing, weigh a stock solution. Ten grams of preservative made up to 100 g with water gives a 10 percent solution, and 1.00 g of that solution carries 0.10 g of preservative. The solution itself must be recorded as a line, and the water it carries counts against the water to 100. This is how a small sample stays honest without pretending the scale is finer than it is.

The record is the product of the whole exercise. It should show the batch number, the formula version, the theoretical weights, the actual weights, the pH, the yield, the date, and the person who signed it. If someone later asks whether the batch that caused a reaction contained fragrance at 0.30 or 0.50 percent, the record answers in seconds. Without it, the answer is a guess dressed as memory. A salon that keeps clean batch records can investigate a complaint, repeat a good batch, and hand a formula to a lab without rewriting history. Keep the sheet for at least as long as the product could still be on a shelf, and longer where the market requires it.

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- 1. Write the batch size in grams at the top of the sheet before any calculation.
- 2. Calculate each weight as batch grams times percent divided by 100, and write it down.
- 3. Recalculate the water line as the remainder after every other line is fixed.
- 4. Add the calculated weights and confirm the total equals the batch size.
- 5. Weigh the smallest lines first on the finer balance, then the oils, then the water.
- 6. Tare each vessel and check the reading before the material goes in, not after.
- 7. Add the actual weights and compare them with the theoretical set, noting any gap.
- 8. Record the yield, pH and signature, and file the sheet with the retained sample.

Bench example: a 400 g batch of the lotion

Use the 100 g sheet from the earlier example: water 77.20, glycerin 5.00, xanthan 0.20, phenoxyethanol 0.80, and the remaining lines 16.80. The factor is 400 divided by 100, which is 4. Multiply every line: water 308.80 g, glycerin 20.00 g, xanthan 0.80 g, phenoxyethanol 3.20 g, and the remaining lines 67.20 g. Check the sum: 308.80 plus 20.00 plus 0.80 plus 3.20 plus 67.20 equals 400.00 g. Weigh xanthan and phenoxyethanol on the 0.01 g balance, the oils on the 0.1 g balance, and water last. Heat phases A and B separately to about 70 to 75 C, combine, and cool with slow stirring. If a 0.50 g sample is taken for pH, the batch is now 399.50 g, and the percent column has shifted by about 0.13 percent relative, which is small but worth a note. Report the yield as filled weight, not as the weight you wished for. Write the factor on the sheet in ink, because a factor remembered from an earlier batch is the commonest source of a doubled water line. A batch scaled by doubling every line, water included, totals 200 percent and cannot be rescued by stirring.

CAUTION

Rounding every line upward can push a batch past 100 percent. Round the display, keep the weighed values, and never let the total drift silently.

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CHAPTER 2

Phases A, B, C and D

Phase A: the water side

Phase A is everything that dissolves or disperses in water, plus the water itself. It usually carries the humectants, the chelator, the water-soluble gums, and any active that survives heat. Glycerin at 3 to 8 percent is common in a moisturiser, both as a humectant and as a dispersion aid for xanthan. A chelator such as disodium EDTA at about 0.10 percent binds the metal ions that can catalyse oxidation and weaken a preservative. Panthenol at 0.5 to 2 percent is a mild humectant and soothing agent. The to-100 water line lives here, and it is the line that absorbs every other change on the sheet.

The order inside phase A matters more than the order between phases for one common fault: lumps. Xanthan gum at about 0.1 to 0.4 percent thickens the water and slows separation, but if it is tipped dry into water it forms fish-eye lumps that no amount of stirring will fully remove. Disperse the gum in the glycerin first, or in a small portion of water, then add the rest of the water with agitation. The same rule applies to other hydrocolloids. A lumpy water phase will show up as a grainy cream even when the emulsion itself is sound, and the fault will be blamed on the emulsifier that had nothing to do with it.

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Phase A is heated with phase B to about 70 to 75 C, not because the water needs it but because the oil phase does. Heating both phases to the same band avoids a thermal shock when they meet, and a shock is one of the usual causes of a split. Hold the heat only as long as it takes to melt the oil phase. A long hot hold drives off volatiles, oxidises oils, and wastes energy. Use a probe thermometer rather than a hand: a beaker that feels comfortable can still be 55 C, and a batch at 55 C is not at 72 C no matter how it feels.

Water quality is part of phase A and is often ignored. Tap water carries hardness, chloride and whatever the building pipes contribute, and those change from day to day. A workshop should use purified or at least filtered water for anything that will be sold, and should record which water was used. Water is also the largest single line in most formulas, so a change in its mineral content changes the product more than a change in a 0.10 percent active. If a batch behaves oddly for no visible reason, the water is a reasonable suspect and an easy one to rule out.

- 1. Weigh the water to 100 last in phase A, after the small water-soluble lines are in the vessel.
- 2. Disperse xanthan at about 0.1 to 0.4 percent in glycerin before it meets the bulk water.
- 3. Add the chelator, usually disodium EDTA at about 0.10 percent, to the water before heating.
- 4. Add glycerin at 3 to 8 percent and panthenol at 0.5 to 2 percent, and stir until clear.
- 5. Heat phase A with phase B to about 70 to 75 C, using a probe thermometer, not a hand.

- 6. Hold the temperature only until the oil phase is fully melted, then combine promptly.
- 7. Check that no gum sits undispersed at the bottom of the vessel before you combine.
- 8. Record the water source, the phase A weights and the temperature at combining.

> **Bench example: phase A for a 500 g lotion**
>
> For 500 g of the lotion, phase A holds water 386.00 g, glycerin 25.00 g, xanthan 0.20 percent which is 1.00 g, disodium EDTA 0.10 percent which is 0.50 g, and panthenol 1.00 percent which is 5.00 g. The small lines together weigh 6.50 g. Weigh the glycerin into a beaker, sprinkle the 1.00 g of xanthan into it while stirring, and let it wet out before adding water. Add the EDTA and panthenol, then the 386.00 g of water, and stir slowly. Heat to about 72 C with phase B. If the xanthan forms lumps, strain the phase through a coarse sieve before heating and note the loss, because a lump in the finished cream is a complaint waiting to happen. Check the total of phase A against the sheet before you apply heat, not after. If the phase is short by more than the tolerance, find the missing line before heating, because heat hides nothing and makes every correction harder. Keep a spare beaker of hot water at the same temperature so the combine is not delayed by a cold vessel.

> CAUTION
>
> Do not add a gum dry to the full water charge. The lumps that form will survive heating and show up in the finished product.

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Phase B: the oil side

Phase B is the oil-soluble group: emollient oils, butters, waxes, the fatty alcohol, the emulsifier pair, and an oil-soluble antioxidant such as tocopherol. In a lotion the oil phase commonly sits at about 10 to 20 percent; in a cream it is more often about 20 to 35 percent. The emulsifier plus fatty alcohol usually totals about 3 to 6 percent in a lotion and about 5 to 8 percent in a cream. Those ranges are starting points, not rules: a high-oil cream needs more emulsifier, and a very light lotion can sit at the bottom of both ranges and still be stable.

Melt the oil phase completely before it meets water. Wax specks and fatty alcohol crystals that survive the combine will not melt out later; they will be suspended in the emulsion as grit. Stir the oil phase gently while it melts, and keep the temperature uniform. A double boiler is safer than a direct flame because it cannot spike, and a controlled hot plate with a probe is better still. Check the phase by looking for the last translucent speck, not by trusting the clock. Different waxes melt at different temperatures, and a blend melts when its highest-melting component has melted.

The oil phase is also where an antioxidant belongs. Tocopherol at about 0.05 to 0.50 percent, or a similar oil-soluble antioxidant, slows rancidity in the oils while the product sits on the shelf. It does nothing about microbes, and it is not a preservative. Add it to the oil phase so it is distributed before the emulsion forms. An antioxidant added after the fact sits in the droplets it landed in and protects only part of the oil. If the formula carries a fragile oil such as a seed oil rich in linoleic acid, the antioxidant matters more, not less.

Choose the oils for the feel you want and the label you can defend, then let the emulsifier follow the oil load. Caprylic/capric triglyceride is a light, stable emollient. Isopropyl myristate is light and spreads well. Dimethicone at about 1 percent adds slip and reduces tack without much occlusion. A butter adds richness and weight, and it also raises the emulsifier demand. Every oil you add changes the required HLB of the blend and the texture of the finished product. The oil phase is not a place to add an ingredient because it sounds good in a brochure. If an oil is added only for the story, it still has to be emulsified, preserved and tested.

- 1. Weigh the oils, butter and wax into a second clean beaker, not into phase A.
- 2. Add the fatty alcohol and the emulsifier pair at the totals the sheet states.
- 3. Add tocopherol at about 0.05 to 0.50 percent to protect the oil blend from rancidity.
- 4. Heat phase B alongside phase A to about 70 to 75 C, with gentle stirring.
- 5. Hold until the last wax speck has melted and the phase is uniform, then stop heating.
- 6. Check the temperature of both phases and confirm they are within about 10 C of each other.
- 7. Pour the oil phase into the water phase in a steady stream while stirring, or as the sheet directs.
- 8. Record the melt temperature, the combine temperature and any oil that had to be replaced.

> **Bench example: phase B for a 500 g lotion**
>
> For 500 g, phase B carries cetearyl alcohol 2.00 percent which is 10.00 g, glyceryl stearate 1.50 percent which is 7.50 g, PEG-100 stearate 1.50 percent which is 7.50 g, caprylic/capric triglyceride 6.00 percent which is 30.00 g, isopropyl myristate 3.00 percent which is 15.00 g, dimethicone 1.00 percent which is 5.00 g, and tocopherol 0.10 percent which is 0.50 g. The phase totals 15.10 percent, or 75.50 g, and the emulsifier plus fatty alcohol is 5.00 percent, inside the 3 to 6 percent lotion range. Heat to about 72 C and stir until the cetearyl alcohol has fully melted and no specks remain. If a speck is still visible at 72 C, raise the temperature by two or three degrees rather than pouring early. Check the weight of the phase before combining, and record the actual melt temperature. If a butter is substituted, check its melting point and adjust the hold temperature, because a butter that melts at 45 C will not be fully liquid at 40 C. Tare the beaker with the stirrer already in place, so the stirrer is not weighed as oil.

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CAUTION

A partially melted oil phase will leave grit that no later stirring can remove. Melt completely, then combine within the same temperature band.

Phase C cool-down and phase D pH

Phase C is added under about 40 C, with slow stirring, one ingredient at a time. It holds the heat-sensitive materials, including some preservatives, fragrance, essential oils, volatile silicones, vitamin C, retinol, and any active whose supplier sheet states a temperature limit. Adding phase C to a hot batch is one of the quiet failures of small-scale work, because the product may look and smell fine while the active has been destroyed or a volatile preservative has flashed off. The ingredient is still on the sheet,

but it is no longer in the jar at the dose the sheet claims. A thermometer beside the vessel, read at every addition, is the cheapest control in the workshop.

Cooling is an active step, not a pause. Stir slowly and steadily while the batch cools, because that keeps the oil droplets small and stops a skin forming at the surface. Fast stirring whips in air, which shows up as foam and as a fill weight that is lighter than the scale suggests. Forced cooling in a fridge is usually a mistake unless the supplier allows it, because uneven cooling makes a skin and can crystallise a fatty alcohol early. A batch cooled too fast can also thicken before every line has been added, trapping phase C near the surface.

Phase D is the adjustment: acid, alkali, salt, or a small premix. Add it in drops with stirring, and recheck after each addition. A pH adjuster added too fast overshoots, and the correction back is another addition that shifts the batch weight again. Measure pH at room temperature on a cooled sample, not on the hot batch, because the reading drifts with temperature. Record the grams of adjuster used, not just the final pH. A line that reads pH adjusted without a weight is an incomplete record, and the next batch will not repeat it. Write the strength of the adjuster solution too, because 0.50 g of a 10 percent acid is not 0.50 g of acid.

A pH adjuster changes the batch weight, and the percent column moves with it. A 100.00 g batch plus 0.50 g of a 10 percent citric acid solution is 100.50 g, and every percentage drops slightly. That is acceptable, but it must be written down, and the water line in the next version of the card should be reduced by the water that came in with the acid. The same logic applies to a salt premix for viscosity and to any small addition made after the batch was balanced. The formula is a living account, not a fixed poster. When the next version is written, the water line carries the correction and the record explains why.

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- 1. Cool the combined batch with slow, steady stirring until it is under about 40 C.
- 2. Check the temperature with a probe before the first phase C addition, and write it down.
- 3. Add the preservative at the temperature its supplier sheet allows, usually in phase C.
- 4. Add fragrance or essential oil last in phase C, below the supplier temperature limit.
- 5. Add one phase C ingredient at a time and stir until it is fully dispersed before the next.
- 6. Take a small sample, cool it to room temperature, and measure pH before adjusting the batch.
- 7. Add phase D in drops with stirring, rechecking pH after every addition, and record the grams.
- 8. Recheck pH after 24 hours and record the drift, because a drifting formula is not yet stable.

Bench example: cool-down and pH adjustment on 500 g

A 500 g lotion batch is combined at about 72 C, then cooled with slow stirring. At 38 C the operator adds phenoxyethanol at 0.80 percent, which is 4.00 g, and ethylhexylglycerin at 0.10 percent, which is 0.50 g, stirring after each. At 35 C comes the fragrance, if the formula has one. The batch is then held at room temperature and a 5 g sample is cooled further for pH. The reading is 5.80 and the target is 5.0 to 5.5. A 10 percent citric acid solution is added in 0.20 g drops; each drop carries 0.02 g of acid. Suppose 1.00 g of solution is needed, so the batch becomes 501.00 g and every percent falls by about 0.2 percent relative. Record the 1.00 g, note the new batch weight, and reduce the water line by 0.90 g in the next version of the card. Recheck the pH the following day and record both readings. If the pH keeps falling between readings, the formula is still reacting, and the batch should not be filled until the reading holds steady for a day.

CAUTION

Do not measure pH on a hot batch and do not write pH adjusted without the weight. Both habits hide a formula that will not repeat.

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CHAPTER 3

Emulsifiers and texture

What an emulsifier does

An emulsion is two liquids that do not mix, held together by a third material. In an oil-in-water lotion, oil is broken into small droplets and those droplets are suspended in water. The emulsifier sits at the boundary, one end in the water and the other in the oil, and it lowers the tension between them. That film also keeps droplets from running into each other and merging. Without the film, the droplets coalesce, the oil rises, and the product separates into a layer you can see. The emulsifier is therefore not a thickener and not a perfume; it is the structure that makes the product a lotion at all.

Oil-in-water, O/W, is the usual cream and lotion. Water is the continuous phase, so the product spreads easily, absorbs, and rinses from the hands. Water-in-oil, W/O, has oil as the continuous phase, so it feels rich, water-resistant and heavy. W/O is harder to preserve because the water sits in isolated droplets, and a small breach in the film can let microbes into a pocket that the preservative reaches slowly. For a first formula, choose O/W unless the brief genuinely needs a barrier balm. Most failures on a small bench come from choosing a W/O system because it sounded more luxurious, then discovering that it splits in the jar.

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HLB is a number that describes how water-loving or oil-loving an emulsifier is. The blend of emulsifiers must match the blend of oils, so a heavier oil usually needs a lower HLB and a lighter oil a higher one. Use the supplier's HLB guide for the named oil and the named emulsifier; do not invent a value from memory. A common workshop pair is glyceryl stearate with PEG-100 stearate, both supplied with a stated HLB. Another is cetearyl alcohol with ceteareth-20. A third is cetearyl olivate with sorbitan olivate. Each pair behaves differently, and the supplier sheet is the map.

A fatty alcohol is not a complete emulsifier. Cetearyl alcohol, cetyl alcohol and stearyl alcohol give body, consistency and a smooth feel, and they support the interface that the true emulsifier has built. They do not form a stable O/W emulsion on their own at normal use levels. This is the commonest confusion in small-scale cream making: a formula with 6 percent cetearyl alcohol and no primary emulsifier will look like a cream while it is warm and separate within days. The fatty alcohol is the scaffolding. The emulsifier is the wall. Read the card and count the two functions separately before deciding that a cream is under-emulsified; often it is simply missing its primary pair.

- 1. Decide the emulsion type from the brief: O/W for most lotions and creams, W/O only for a barrier product.
- 2. List the oils and their percents, and total them to find the oil load before choosing an emulsifier.
- 3. Look up the supplier HLB value for each named oil and for each emulsifier in the pair.

- 4. Pick an emulsifier pair whose blend HLB matches the oil blend, and keep both names on the card.
- 5. Add a fatty alcohol at about 2 to 3 percent for body, and count it as support, not as emulsifier.
- 6. Keep the emulsifier plus fatty alcohol near the stated range, about 3 to 6 percent for a lotion.
- 7. Combine phases at the same temperature, about 70 to 75 C, with steady stirring.
- 8. Check the batch after 24 hours and again at week one for a water layer or oil droplets.

> **Bench example: reading a pair on a supplier sheet**
>
> Two suppliers quote the same pair, glyceryl stearate and PEG-100 stearate. One sells a flake with a stated HLB near 11, intended for a light lotion. The other sells a self-emulsifying grade with a different ratio and a stated HLB near 7, intended for a richer cream. The trade name may look identical on both bags. If the bench copies a 5 percent total from one sheet to the other without reading the grade, the lotion may be thin at one extreme or heavy and waxy at the other. Write the grade, the HLB and the supplier beside the weight on the batch record. Then make a 100 g trial, hold it at room temperature for a week, and look for a ring of water at the jar edge. The supplier guide chooses the starting pair; the trial decides whether that pair works in this formula, with this oil load, at this pH. Keep the trial jar labelled with the pair, the grade and the HLB, because a cream that fails can teach you something only if you know what was in it.

CAUTION

Never treat a fatty alcohol as the emulsifier. If the pair is missing, the cream will look right warm and separate cold.

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Choosing the level

The level of emulsifier follows the oil load, not a habit. A lotion usually carries about 10 to 20 percent oil phase and about 3 to 6 percent emulsifier plus fatty alcohol. A cream usually carries about 20 to 35 percent oil phase and about 5 to 8 percent emulsifier plus fatty alcohol. Within those bands, a higher oil load needs more emulsifier and often a lower HLB. A very light lotion can sit at the bottom of both ranges, and a rich night cream can sit at the top of both. The numbers are a starting point for a trial, not a guarantee of stability.

Build the oil phase first and let the emulsifier follow. If the oils total 15 percent, an emulsifier system at 5 percent is a reasonable start, as the sample card below shows. If the oils total 25 percent, a 5 percent system is thin and a 7 percent system is more likely to hold. When the oil load changes, the water line takes the difference, so the total stays at 100.00. Adding 10 g of oil to a 100 g batch is not a matter of adding 10 g and stirring; it means 10 g more oil, probably 1 to 2 g more emulsifier, and 11 to 12 g less water.

Stability is the test of the choice, not the appearance on the day of making. A lotion that looks glossy in the beaker can grow a water layer at week two if the emulsifier is marginal or the HLB is wrong for the oil blend. A cream that feels heavy and rich on day one can turn grainy by week four if the fatty

alcohol crystallised during a slow cool. Judge the level by what the sample does in the pack you will actually sell, at room temperature and in a warm cupboard, not by the look in the mixing bowl.

Cost and label also shape the level, within reason. A higher emulsifier total costs more per kilogram and can feel heavier or soapier on the skin. A lower total saves material and feels lighter but leaves less margin for a process mistake. The right choice is the lowest level that holds the oil load through the stability screen with a margin, not the lowest level that survived one batch. Margin is what protects you when a supplier changes a grade or an operator combines two phases a few degrees apart. A formula with no margin is a formula that works only on the day it was written.

- 1. Total the oil phase first, including the emulsifier and the fatty alcohol, and write the number down.
- 2. Choose a starting emulsifier total from the band: about 3 to 6 percent for a lotion, 5 to 8 percent for a cream.
- 3. Match the emulsifier blend HLB to the oil blend using the supplier guide for each named oil.
- 4. Set the fatty alcohol at about 2 to 3 percent for body, and count it inside the emulsifier total.
- 5. Recalculate the water line so the sheet still totals 100.00 after any change.
- 6. Make a 100 g trial before scaling, and keep a control with no active for comparison.
- 7. Hold the trial at room temperature and at about 40 to 45 C, and read it at week one and week four.
- 8. Raise the emulsifier only if the trial shows separation, and change one variable at a time.

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> **Bench example: the 100 g lotion card and a richer version**
>
> The 100 g lotion card reads water to 100 at 77.20; glycerin 5.00; xanthan 0.20; disodium EDTA 0.10; panthenol 1.00; cetearyl alcohol 2.00; glyceryl stearate 1.50; PEG-100 stearate 1.50; caprylic/capric triglyceride 6.00; isopropyl myristate 3.00; dimethicone 1.00; phenoxyethanol 0.80; ethylhexylglycerin 0.10; tocopherol 0.10; citric acid 10 percent solution 0.50. The lines total 100.00, the emulsifier plus fatty alcohol is 5.00 percent, and the oil phase is 15.10 percent. To make a richer cream, add 9.90 g of oil, raise the fatty alcohol from 2.00 to 4.00 g so the emulsifier plus fatty alcohol total becomes 7.00 percent, and let water fall by 11.90 g to 65.30 g. Check the new column: 65.30 plus 5.00 plus 0.20 plus 0.10 plus 1.00 plus 4.00 plus 1.50 plus 1.50 plus 6.00 plus 3.00 plus 1.00 plus 9.90 plus 0.80 plus 0.10 plus 0.10 plus 0.50 equals 100.00. The oil phase is now 27.00 percent, inside the 20 to 35 percent cream band, and the water absorbed the whole change. The emulsifier plus fatty alcohol is 7.00 percent, inside the 5 to 8 percent cream band. Then make 100 g and hold it for four weeks before you commit the salon to a larger batch, because a card that balances on paper can still fail in a jar.

CAUTION

Do not raise the oil load without raising the emulsifier and lowering the water. A cream built by addition alone will not total 100.

Thickeners and feel

Xanthan gum at about 0.1 to 0.4 percent thickens the water phase and slows separation. It also holds the oil droplets in place while the batch cools, which is why a lotion with a little xanthan is more forgiving than one without. Above about 0.5 percent it can feel slimy and stringy, and it can leave a tacky film that clients notice. Disperse it in glycerin or in a small portion of water before it meets the bulk, because dry gum in water forms lumps that survive heating. Xanthan is a helper, not a substitute for a correct emulsifier level.

Fatty alcohols and consistency agents build the body of a cream. Cetearyl alcohol at about 2 to 3 percent gives a smooth, non-greasy structure. A small amount of a wax, such as beeswax or a synthetic wax, can add firmness, but wax also raises the melting point and can make the cream feel heavy or draggy. Too much fatty alcohol gives a waxy, soap-like feel and a cream that balls up under the fingers. The goal is a product that spreads in a thin film without dragging, and that is a matter of total solids, not of one ingredient. If the cream balls up under the fingers, reduce the fatty alcohol or the wax before you touch the emulsifier.

Emollients change the after-feel. Caprylic/capric triglyceride is light and stable. Isopropyl myristate spreads well and can feel dry rather than oily. Dimethicone at about 1 percent adds slip and reduces tack, and it can make a cream feel smoother without adding much oil. Glycerin at 3 to 8 percent draws water into the upper skin, but above about 10 percent it feels sticky and can sting on a broken surface. Every one of these is a sensory decision as much as a chemical one, and the client is the final judge, provided the stability and preservation are already sound. Ask a colleague to use the sample for a week and describe the feel in their own words.

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Measure texture rather than describing it. Viscosity on a rotating spindle at a stated speed and temperature is a number that can be compared between batches. Spreadability on a glass plate is a rough but useful bench check. A texture that changes between batch one and batch four is a process signal: the emulsifier level, the cool-down rate or the homogeniser time has drifted. Keep the numbers with the sample, and describe the feel in plain words that a colleague can repeat. Smooth, tacky, draggy, waxy and grainy mean something specific, and each points to a different line on the card.

- 1. Disperse xanthan at about 0.1 to 0.4 percent in glycerin before adding bulk water.
- 2. Keep the fatty alcohol near 2 to 3 percent and count it inside the emulsifier total.
- 3. Add a wax only if the brief needs firmness, and expect a higher melt point and a heavier feel.
- 4. Adjust emollients for after-feel, not for claims: light esters, a little dimethicone, a stable triglyceride.
- 5. Keep glycerin between 3 and 8 percent and stay below about 10 percent unless the brief demands more.
- 6. Measure viscosity at a stated temperature and spindle speed, and record the number.
- 7. Compare texture at day one, week one and week four, using the same method each time.
- 8. Change one texture variable at a time, or you will not know which one worked.

Bench example: thickening a thin lotion without breaking it

A 200 g trial lotion comes off the bench thin, almost watery, and the operator wants to add xanthan. The emulsifier total is 5.00 percent and the oil phase is 15.10 percent, so the emulsifier is not obviously the problem. Before changing it, check the pH, the combine temperature and the cool-down rate. Suppose the batch was combined at 60 C because the oil phase was not hot enough. The emulsion formed poorly and the thickness never developed. Raising xanthan from 0.20 to 0.40 percent would make the lotion feel slimy without fixing the emulsion. Instead, remake the batch with both phases at 72 C and the same emulsifier level, and hold a 0.30 percent xanthan trial beside it. Compare viscosity at week one. The likely answer is the process, not the gum, and the record shows which change was made. A second trial with xanthan at 0.30 percent tells you whether the gum helps or merely hides the fault; without the first trial you would never know. Keep both jars on the same shelf for four weeks and compare them at the end, because a fault that appears at week three is still a fault.

CAUTION

Do not thicken a separated emulsion with gum. Gum hides the water layer for a week and then the product fails in the client's bathroom.

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CHAPTER 4

Surfactants and active matter

Active matter arithmetic

A surfactant raw material is rarely 100 percent active. Sodium Laureth Sulfate is commonly sold as a 70 percent paste, cocamidopropyl betaine as a 30 percent solution, and many blends at similar strengths. The percent on the formula sheet is the weight of the raw material, while the percent that cleans is the active matter inside it. Confusing the two is the most common reason a shampoo is either harsh or weak. A 70 percent paste for 10 percent active weighs 14.3 g per 100 g of product, because 14.3 multiplied by 0.70 is 10.01. Writing 10.00 g of paste would give only 7.00 g of active and a thinner, weaker foam.

The primary anionic surfactant is often used at about 8 to 12 percent active matter in a shampoo. Below that band the foam is weak and the product feels underpowered; above it the shampoo cleans well but strips the scalp and hair, especially with daily use. The amphoteric, usually cocamidopropyl betaine, is often used at about 2 to 5 percent active matter. It softens the harshness of the anionic, improves foam quality, and helps the viscosity build. A non-ionic such as a glucoside can add mildness, and a cationic polymer can improve wet comb, but neither replaces the primary anionic at the same weight.

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Do the arithmetic before you weigh, and write both numbers on the card. The raw material weight goes in the percent column; the active matter goes in a note. When a supplier changes the strength of a paste from 70 to 68 percent, the raw material weight must rise to keep the same active, and the water line must fall to keep the total at 100.00. This is a real change that happens without warning, and a shampoo can change character overnight if nobody checks. Add the active matter calculation to the batch record, not just to the training notes.

Active matter also drives the claims and the cost. A shampoo that says 12 percent active on the front and delivers 8 percent in the bottle is a claim problem as well as a performance problem. The label on a retail cosmetic must declare ingredients in descending order of predominance, so the surfactant system sits high in the list and should correspond to the formula. Keeping the arithmetic honest is therefore not only bench hygiene; it is the basis on which the label can be defended if someone reads it against the batch record. A label that cannot be matched to a batch record is a claim with nothing behind it.

- 1. Read the as-supplied strength on the surfactant data sheet before any calculation.
- 2. Convert grams of raw material to grams of active matter by multiplying by the strength.
- 3. For 10 percent active from a 70 percent paste, weigh 14.3 g per 100 g of product.

- 4. Set the primary anionic target at about 8 to 12 percent active matter for a shampoo.
- 5. Set the betaine at about 2 to 5 percent active matter, and count its own strength separately.
- 6. Add the active matter figures in the notes column, not in the percent column.
- 7. Recalculate the raw material weight if the supplied strength changes, and adjust water to 100.
- 8. Compare the finished foam and feel against the active matter target, not against the raw weight.

> **Bench example: two pastes, same formula weight**
>
> A 100 g shampoo card calls for 14.30 g of a 70 percent Sodium Laureth Sulfate paste, which gives 10.01 g of active. The supplier runs out and sends a 68 percent paste. If the bench weighs 14.30 g of the new paste, the active falls to 9.72 g, a loss of about 0.29 g, or roughly 3 percent of the surfactant system. That is enough to change the foam and the salt curve. To hold the target, divide 10.01 by 0.68, which gives 14.72 g of the new paste. The extra 0.42 g comes out of the water line, which falls from 68.30 to 67.88 g, and the sheet still totals 100.00. Write the paste strength, the calculation and the new water line on the batch record. A shampoo is a system, and a small change in active matter moves the viscosity peak as well. Record the new paste strength in the notes, and tell the person who fills the bottles, because the batch carries the change even when the label declaration does not. Write the calculation in the notes so the next person can follow it.

CAUTION

Never swap a surfactant paste for another strength at the same weight. Recalculate the active matter, then let water absorb the difference.

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Building a shampoo

A shampoo is a surfactant system with water, a thickener, conditioning agents and a preservative. Build it in an order that avoids foam and protects the small lines. Disperse any gum or polymer in water or glycerin first, add the water-soluble ingredients, then the primary anionic with slow stirring. Add the amphoteric and the non-ionic next, then the conditioning polymer. Adjust pH before the salt, because salt thickens differently at different pH values. Add preservative and fragrance under 40 C, then the salt premix in steps to the viscosity peak, and recheck the pH at the end. If the batch foams during mixing, let it stand; trapped air makes every reading unreliable and every fill weight light.

Do not aerate the batch. Foam in the making vessel wastes raw material, traps air in the bottle, and makes the fill weight wrong. Stir with a paddle at a speed that moves the liquid without folding air into it. If foam forms, let the batch stand rather than stirring harder. A shampoo that is full of bubbles at filling can settle in the bottle and leave a headspace that looks like a short fill. The same trapped air makes a viscosity reading unreliable, so measure after the batch has stood and the bubbles have risen. A degassing pause of ten minutes is cheaper than a bottle that looks half empty on the shelf.

Preservation needs care in a shampoo because the pH and the surfactant load both affect the system. Organic acids such as sodium benzoate and potassium sorbate work in the acid form and generally need a product pH under about 5.5. A shampoo at pH 5.0 to 6.5 sits near the edge, and at the top of

that range the acids are less effective. A chelator supports the system but is not a preservative. A challenge test on the finished formula, in the finished pack, is the only proof that the system works. Rinse-off products have a shorter contact time, but they still grow microbes in the bottle between uses.

Viscosity, pH and foam are the three readings that tell you the batch is right. Record them at a stated temperature, because a shampoo thick at 20 C can be thin at 35 C and the client may notice. Check the appearance in a clear sample jar against a light: a hazy shampoo may be a fragrance that is not solubilised, a polymer that has not hydrated, or a preservative that has dropped out. Each has a different fix, and none of them is fixed by adding more salt. The batch record should carry the readings, the salt total and the order of addition.

- 1. Disperse the polymer or gum in water or glycerin before the surfactants go in.
- 2. Add the water and water-soluble lines, and warm gently only if a raw material needs it.
- 3. Add the primary anionic slowly, with a paddle, to avoid folding air into the batch.
- 4. Add the betaine and any non-ionic, then the conditioning polymer, one at a time.
- 5. Add the chelator, then set the pH to the target before any salt is weighed.
- 6. Add the preservative at the temperature its supplier sheet allows, then the fragrance under 40 C.
- 7. Add the salt as a premix in steps, checking viscosity after each addition, and stop at the peak.
- 8. Recheck pH, viscosity and appearance, and record all three with the temperature.

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Bench example: clear shampoo, 100 g

Formula for 100 g, figures in grams. Sodium Laureth Sulfate 70 percent paste 14.30; Cocamidopropyl Betaine 30 percent 10.00; PEG-7 Glyceryl Cocoate 2.00; Glycerin 2.00; Polyquaternium-7 0.50; Sodium Chloride 1.20; Citric acid 10 percent solution 0.50; Phenoxyethanol at the supplier dose 0.80; Disodium EDTA 0.10; Fragrance 0.30; water to 100 68.30. The lines total 100.00 g. Active primary surfactant is 14.30 times 0.70, which is 10.01 g, about 10 percent. Active betaine is 10.00 times 0.30, which is 3.00 g, inside the 2 to 5 percent band. Dissolve the surfactants in the water, add the rest except salt and fragrance, adjust pH to about 5.5, then add the salt premix to the target viscosity. Cool, add preservative and fragrance, and recheck pH. Confirm every dose with the supplier sheet and run a challenge test before sale. Every weight belongs in the batch record. If the batch is to be sold, keep a retained sample and send the formula for a challenge test before the first bottle leaves the salon. The pH and viscosity readings belong on the same page as the weights.

CAUTION

Do not add salt before the pH is set. The same salt level can thicken at one pH and thin at another, and the batch cannot be undone.

The salt curve

Salt thickens a sulfate shampoo, but only up to a point. As sodium chloride is added, viscosity rises, reaches a peak, and then falls again as the micelle structure changes. The peak is different for every surfactant blend, every active matter level and every pH. That is why salt is added as a premix in small steps with a viscosity check after each one, and why the total in the formula is a starting charge rather than a fixed law. A formula that lists 1.20 percent salt may need 0.90 or 1.60 in a particular batch, and the record should show what was actually used.

Temperature changes the reading. A shampoo measured warm is thinner than the same shampoo at room temperature, and a batch measured in a cold room is thicker. Fix a temperature for the measurement, usually 25 C, and let the sample stand long enough to reach it. Fix the spindle and speed as well. A reading without those three parameters is a number that cannot be compared with anything, including the next batch of the same formula. Write them beside the result, every time. A reading taken at 30 C and compared with one taken at 20 C will suggest a change that did not happen.

Salt is not the only thickener, and it is not always the right one. A PEG-based thickener, a betaine at a higher level, or a small amount of a gum can build viscosity in systems where salt does not respond. A sulfate-free system often needs a different thickener entirely, because the salt curve may be flat or inverted. Before adding salt to a formula that will not thicken, check the active matter, the pH and the polymer hydration. Salt cannot rescue a system that has too little surfactant or a pH far from the target. Read the supplier sheet for the thickener before you add it, because some thickeners need a pH range of their own.

Too much salt is worse than too little. Past the peak, the shampoo thins, and adding more salt makes it thinner still. The batch is then difficult to correct without diluting, which changes every percentage. The safe habit is to stop a little before the peak, measure, and add the last increment slowly. If the batch overshoots, record it and adjust the formula for the next version rather than pretending the salt line was always right. A shampoo that is slightly thinner than target is a product; one that has passed the peak and lost its structure is a rework.

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- 1. Set the pH before the first salt addition, and record the reading.
- 2. Make a 20 percent sodium chloride premix so small increments can be weighed accurately.
- 3. Add the premix in steps of about 0.20 percent of the batch, stirring until uniform.
- 4. Measure viscosity after each step at a fixed temperature, spindle and speed.
- 5. Stop when the viscosity stops rising, and add no more salt after the peak.
- 6. Record the total salt used, including the water that came with the premix.
- 7. Reduce the water line in the next version by the premix weight, so the sheet still totals 100.00.
- 8. If the batch passes the peak, stop adding and note the deviation rather than diluting blindly.

Bench example: finding the peak on a 500 g batch

A 500 g shampoo batch is at pH 5.4 and reads 1800 centipoise at 25 C. A 20 percent salt premix is added in 5.00 g steps, which is 1.00 percent of the batch, and each step carries 1.00 g of salt. After the first step the reading is 2600, after the second 3900, after the third 4800, and after the fourth 4600. The peak sits between the third and fourth steps, so the batch has passed it. The total salt is 4.00 g, or 0.80 percent, plus the water in the premix, which is 16.00 g. The batch now weighs 520.00 g, and the water line must be reduced by 16.00 g in the next version. Record the peak, the salt total and the new batch weight. If the product is too thick to fill, a small dilution is a new formula version, not a correction to the old one. A dilution changes the active matter and the preservative dose, so it needs a new card, a new pH check and a new challenge test if the product is sold. That is a decision for the owner, not a quiet adjustment at the sink.

CAUTION

Past the salt peak, more salt makes a shampoo thinner. Stop before the peak and record the total, or the next batch will overshoot again.

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CHAPTER 5

Preservatives

Water needs a preservative

Any formula that contains water can grow bacteria, yeast and mould. Water is the medium, and the small amounts of sugar, protein, gum and plant extract that make a product pleasant are also food. A cream that is 70 percent water and has no preservative is not a natural product; it is a growth medium with a lid. The risk is not theoretical, and it does not depend on how clean the bench looked. Pseudomonas, Staphylococcus and Candida are common in contaminated cosmetics, and a jar that a client keeps in a warm bathroom gives them everything they need. A preservative is not optional in a water product.

Water activity, pH and packaging decide how fast the problem arrives. A product with high free water, a near-neutral pH and a jar that fingers enter is the hardest case. A rinse-off product with a low pH and a pump is easier, but easier is not safe. Adding salt or glycerin lowers water activity a little, and that helps, but it does not replace a preservative system. Nor does a low pH by itself stop mould. Each factor shifts the odds; only a preserved, tested formula changes them enough to sell. A product with a preservative that has never been tested is still an untested product.

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There is one honest exception, and it is narrow. An anhydrous product, with no water and no water entering in use, does not support microbial growth in the same way, so it needs an antioxidant rather than a preservative. A lip balm, a body oil and a water-free balm can fall into that group. The moment water is added, or the moment a product is used with wet hands, the exception ends. A scrub with sugar and oil that is kept in the shower is not anhydrous in use, because water reaches it every day. When in doubt, treat the product as a water product.

Hygiene buys time but does not replace the system. Clean vessels, filtered water, a closed batch, a sanitised filler and a trained operator all reduce the starting load. They do not stop the client from introducing microbes on the first use. A preservative system that is correctly dosed, compatible with the formula, and proven by a challenge test is the only part of the control that keeps working after the jar is opened. A workshop that sells without one is selling an experiment to a person who did not agree to be in it. That is why the preservative and its test appear in the planning, not in the last week before launch.

- 1. Ask whether the formula contains water, or will meet water in normal use, before anything else.
- 2. If yes, plan a preservative system from the first draft, not after the batch is stable.
- 3. Note the pH, because the system must work inside its own pH window.
- 4. Note the pack, because a jar that fingers enter needs more protection than a sealed pump.

- 5. Note the use, because a rinse-off has a shorter contact time than a leave-on.
- 6. Keep the water, vessels and filling area clean, and record the cleaning.
- 7. Do not call a water product natural or preservative-free and put it in a jar for a client.
- 8. Book a challenge test before the first sale, and keep the report with the batch record.

> **Bench example: the same cream in two packs**
>
> A 100 g moisturiser is made to the lotion card: water 77.20, glycerin 5.00, xanthan 0.20, disodium EDTA 0.10, panthenol 1.00, cetearyl alcohol 2.00, glyceryl stearate 1.50, PEG-100 stearate 1.50, caprylic/capric triglyceride 6.00, isopropyl myristate 3.00, dimethicone 1.00, phenoxyethanol at the supplier dose 0.80, ethylhexylglycerin 0.10, tocopherol 0.10, citric acid 10 percent solution 0.50. The pH is 5.2. Filled into an airless pump, the product is protected from fingers and from air. Filled into a wide 100 g jar, the same formula is opened, touched and left open in a steamy bathroom. The preservative system is identical, but the challenge is not. If the salon sells both packs, the jar deserves the more conservative system and the earlier re-test. The formula is only half the decision; the pack is the other half. If the salon sells both, the jar carries the earlier re-test date and the clearer use instruction, because the client's fingers are part of the system. Write the pack type on the batch record beside the batch number, and remember that a pump refilled from a bulk jar is not a pump any more.

CAUTION

Never sell a water-based cream or lotion without a preservative system and a challenge test. A clean bench does not make a product self-preserving.

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Choosing and dosing

Do not invent a preservative percent. Use the supplier data sheet: it gives the use level, the pH window, the temperature limit and the compatible partners. The dose is the use level, not a suggestion, and the pH window is the range where the material actually works. A preservative used below its dose, outside its pH, or added to a batch that is too hot is a line on a sheet that does nothing in the jar. Read the sheet for the grade you bought, because the same INCI name can be supplied in different blends and at different recommended levels.

A legal ceiling is not a target. Phenoxyethanol is commonly limited to 1.0 percent in the European Union, and benzyl alcohol as a preservative is commonly limited to 1.0 percent there as well. Those numbers are the top of the legal range. A formula that uses phenoxyethanol at 0.80 percent does so because the supplier dose, the pH, the pack and the challenge test support that level, not because the ceiling is 1.0. Starting at the ceiling leaves no room, adds irritation risk, and usually signals that nobody read the sheet. Choose the lowest dose that passes the test in the actual formula.

Organic acids work in the acid form. Sodium benzoate and potassium sorbate generally need a product pH under about 5.5, and their effect falls as the pH rises. That is why a shampoo at pH 6.0 is a harder preservation case than a lotion at pH 5.0, and why a benzoate and sorbate pair is common in a shampoo but must still be tested. A single acid is often weak against mould or against Pseudomonas.

A chelator such as disodium EDTA supports the system by binding metals, and a booster such as ethylhexylglycerin at about 0.1 to 0.5 percent can improve performance, but neither is a complete system on its own.

Temperature and phase decide where the preservative goes. Some materials tolerate the hot phase, and some must be added under 40 C. A volatile preservative added to a hot batch can flash off, leaving the product underdosed while the sheet still reads correctly. Add it at the temperature the supplier allows, stir it in fully, and record the batch temperature at that moment. If the formula also contains a fragrance or an essential oil, remember that those are allergens and fragrances, not preservatives, and they do not reduce the dose of the real system. A fragrance allergen declaration is a labelling duty, not a substitute for preservation.

- 1. Read the supplier sheet for the exact grade, and write the recommended dose on the card.
- 2. Compare that dose with the legal ceiling in the market of sale, and use the lower figure.
- 3. Check the pH window of the system against the pH the formula will actually have.
- 4. Decide the phase from the temperature limit: hot phase only if the sheet allows it.
- 5. Add a booster only as support, never as a replacement for the primary preservative.
- 6. Keep a chelator such as disodium EDTA at about 0.10 percent to support the system.
- 7. Record the actual weight, the batch temperature and the pH at the addition.
- 8. Confirm the choice with a challenge test in the finished formula and pack.

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Bench example: dosing a lotion without starting at the ceiling

The lotion card carries phenoxyethanol at 0.80 percent and ethylhexylglycerin at 0.10 percent. The supplier sheet for the phenoxyethanol grade states a use level of 0.5 to 1.0 percent, a pH range from about 3 to 8, and addition below 60 C. The formula sits at pH 5.2 and the pack is a pump, so the system has an easy pH and a protected pack. A 0.80 percent dose is inside the supplier range and below the 1.0 percent EU ceiling, which is a ceiling and not a target. In a 500 g batch that is 4.00 g of phenoxyethanol and 0.50 g of ethylhexylglycerin, both added at 38 C. If the challenge test at week four shows a weak result against mould, the answer is a different system or a higher tested dose, not a jump to the ceiling. Change one variable, re-test, and record both reports. If the test fails, do not raise the dose quietly; change one variable, such as the booster or the pack, and re-test. Record the reason on the card, so the next batch inherits the lesson and not the guess.

CAUTION

A preservative ceiling is the top of the legal range, not a dose. Never raise a dose to the ceiling to avoid doing a challenge test.

The challenge test

A challenge test, also called a preservative efficacy test, deliberately contaminates a sample with known microbes and measures how well the formula kills them or holds them down. It is run to a

standard method, commonly ISO 11930, and it uses a defined set of bacteria, yeast and mould. The lab inoculates the product, samples it at set intervals, and counts what survives. Pass criteria depend on the category of product and on the method, and the report states them. This is the proof that a preservative system works, and no bench observation replaces it. Ask the lab to state the method and the pass criteria in the report, so the result can be read by someone who was not there.

The test must use the finished formula in its final pack. A system that passes in a pH 5.5 lotion may fail in a pH 3.5 serum, and one that passes in a gel may partition into the oil phase of a cream and leave the water underprotected. The pack matters too, because a jar that fingers enter is inoculated by the client every day, while a pump is not. Send the sample the salon will actually sell, with the same preservative dose and the same pH, and tell the lab how the product is used. A report for a different formula is not a report for this one.

Timing matters. A challenge test takes weeks, so it belongs in the plan from the first trial, not at the end of the launch. Stability can run in parallel. A common pattern is a four-week screen first, then the formal test on the version that will be sold, with a retained sample kept from the same batch. If the formula changes after the test, the report no longer applies, even if the change looks small. Raising the glycerin, lowering the pH or swapping an emulsifier can all move the result. Write the test date and the formula version on the report, and file it beside the batch record so the two can be matched.

A smell test is not a microbial test, and a clear product is not a clean product. Contamination can be invisible and odourless at the start. The one-week smell check that many small workshops use is a spoilage alarm at best, and it usually goes off after the product has already been sold. If a batch smells wrong, treat it as contaminated until a lab says otherwise: quarantine it, do not sell it, and find out what happened in the process. The cost of a test is small against the cost of a client with a skin infection. That is not a cost the salon can absorb quietly, and it is not a risk the client agreed to take.

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- 1. Choose the formula version that will be sold, and make a batch in the final pack.
- 2. Send the sample to a laboratory that runs a recognised method, commonly ISO 11930.
- 3. State the product category, the pH, the preservative dose and how the client will use it.
- 4. Ask for the raw counts and the log reductions at each sampling point, not only a pass or fail.
- 5. Keep a retained sample from the same batch beside the test sample.
- 6. Run stability in parallel, and record both sets of results against the same batch number.
- 7. Re-test after any change to the preservative, the pH, the pack or a major ingredient.
- 8. File the report with the batch record, and do not sell before it passes.

Bench example: planning a test before the launch

A salon plans to sell a 50 g jar of the lotion and a 200 ml pump of the same lotion. The jar is the harder case. The plan is to make a 2 kg batch at pH 5.2 with phenoxyethanol at 0.80 percent, fill six jars and six pumps, and keep two of each as retained samples. Three jars and three pumps go to the lab for a challenge test to ISO 11930, and the rest go on a four-week stability shelf at room temperature and at about 40 C. The lab report comes back with the counts for each organism at each interval, and the jar series is watched more closely because fingers enter it. If the jar passes but the margin is thin, the next version uses a different system rather than a higher dose. The batch number on the report matches the batch number on the jar. Nothing is sold until both the test and the stability screen are in the file. Keep the packing slip and the lab's sample receipt with the batch, because a report is evidence only if it can be tied to the jar.

CAUTION

Do not judge a preservative by smell, colour or a one-week check. Only a challenge test on the finished formula supports a sale.

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CHAPTER 6

Actives, ranges and limits

Humectants and niacinamide

Glycerin is the workhorse humectant, usually at 3 to 8 percent in a cream or lotion. It draws water into the upper layers of the skin and it also helps disperse xanthan. Above about 10 percent it feels sticky, and in very dry air it can pull water from the skin rather than from the room. Propanediol and butylene glycol at 2 to 5 percent are alternative humectants and solvents, useful when a formula needs to dissolve a poorly soluble active. Panthenol at 0.5 to 2 percent is a mild humectant with a soothing reputation, and it is sticky above about 2 percent. None of these is a drug, and none of them repairs a barrier on its own.

Hyaluronic acid is a humectant, not a preservative. High molecular weight grades at about 0.1 to 0.5 percent form a surface film and hold water at the skin surface. Low molecular weight grades at similar levels feel less filmy and are marketed as deeper, though the claim outruns the evidence. Both can gel a batch if overused, and both can sting on broken skin. A hyaluronic serum with no preservative grows microbes exactly like any other water product. The percent is small, which makes it easy to forget that the water around it is still a growth medium. The dose is small, so write it as a percentage of the batch and weigh it on a balance that can see it.

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Niacinamide is commonly used at 2 to 5 percent in a leave-on, and some products go to 10 percent. It supports the barrier and improves the look of tone over time, and it is generally well tolerated. It flushes some faces, especially at higher levels, and it can sting on a compromised barrier. Niacinamide is a cosmetic active; it is not an acne treatment, and a product that claims to treat acne with it is making a drug claim. Start at 2 to 3 percent in a new formula, keep a base sample without it, and compare the two after four weeks before deciding that a higher level is worth the irritation risk.

The rule for all humectants is the same: dose for comfort, not for the story. A humectant that makes a product tacky or that stings will not be used by the client, and an unused product cannot deliver anything. Build the base first, confirm that it is stable and preserved, then add the active and compare. Keep the active's lot number and weight in the record, because the active is the line most likely to be questioned later. A base you trust plus one active is a test. A base and three actives changed at once is a guess with a label on it.

- 1. Set glycerin at 3 to 8 percent, and stay below about 10 percent unless the brief justifies more.
- 2. Use propanediol or butylene glycol at 2 to 5 percent when a solvent is also needed.
- 3. Add panthenol at 0.5 to 2 percent, and expect tack above 2 percent.
- 4. Use hyaluronic acid at about 0.1 to 0.5 percent, and never count it as a preservative.

- 5. Set niacinamide at 2 to 5 percent, starting at the lower end for a new formula.
- 6. Keep a base sample with no active, and compare colour, smell, pH and feel at week four.
- 7. Record the active's lot number and actual weight in the batch record.
- 8. Write only cosmetic claims for these ingredients, and keep acne and repair language off the label.

> **Bench example: a 100 g niacinamide gel-cream**
>
> A light gel-cream for oily-looking skin is built on the lotion base, with the oil phase reduced and the water raised. Water to 100 82.20; glycerin 4.00; niacinamide 4.00; xanthan 0.30; disodium EDTA 0.10; panthenol 1.00; cetearyl alcohol 2.00; glyceryl stearate 1.50; PEG-100 stearate 1.50; caprylic/capric triglyceride 2.00; dimethicone 0.50; phenoxyethanol at the supplier dose 0.80; ethylhexylglycerin 0.10. The lines total 100.00, the emulsifier plus fatty alcohol is 5.00 percent, and the oil phase is 7.50 percent, which is light for a lotion but workable with the gum. Niacinamide sits at 4.00 percent, inside the 2 to 5 percent band. Add it to the water phase if the supplier allows heat, or to phase C if not, and check the pH at 5.2. Hold a base sample without niacinamide beside it, and compare the two at week four before the salon commits. If the niacinamide flushes a tester at 4 percent, drop to 2 percent and repeat, because comfort is part of the formula. A product that stings is a product that stays on the shelf, and the base jar stays on the bench for comparison.

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CAUTION

Do not call niacinamide an acne treatment or a repair ingredient. It is a cosmetic active, and the claim decides whether the product is a drug.

Acids and retinoids

Salicylic acid is used for exfoliation and for the look of pores, often at or below 2 percent in a leave-on cosmetic. It needs a solvent, usually a glycol or an alcohol, and an acidic pH to stay dissolved and active. Many markets cap leave-on cosmetics at 2 percent, and an acne treatment claim can make the product a drug, which changes the rules entirely. Do not use it on a large broken area, do not put it in a product for children, and confirm the current local limit before a salon uses it. A 2 percent product that also claims to treat acne is not a cosmetic in most markets, whatever the bottle says.

L-ascorbic acid is an antioxidant and a cosmetic active for the look of tone. It is used at 5 to 15 percent at a pH near or under 3.5, because the acid form is the active form. It is unstable in water and air: it yellows, loses strength, and can turn a clear serum brown within weeks. A workshop serum therefore needs a low-oxygen pack, a chelator, and a short shelf life, or a more stable derivative at a lower percent. Do not mix fresh ascorbic acid into a high-pH cream and call it stable; the pH is wrong and the oxygen is already in the jar.

Retinol is used at 0.1 to 0.3 percent to start in a consumer leave-on, for the look of tone and texture over time. It is sensitive to air and light and is usually packed in an airless or opaque container with a chelator. Irritation, peeling and redness are common at the start, so a lower level for a shorter contact

time is a reasonable beginning. On pregnancy, do not recommend it: tell the client to ask their doctor. This text does not cover tretinoin, which is a prescription drug and not a cosmetic ingredient, and no formula here includes it.

Acids and retinoids change the formula around them. Salicylic acid needs a solvent and an acid pH. Ascorbic acid needs a low pH and a low-oxygen pack. Retinol needs an airless or opaque pack, and often a chelator. Build the base for the active, not the other way round, and check the supplier's pH and temperature limits before you weigh. A product that contains one of these at the wrong pH is not a weaker version of the product; it is a different, unstable product with the same label. The supplier sheet is the first check, and the finished pH is the second.

- 1. Confirm the current local limit for salicylic acid before writing the line, and stay at or below 2 percent.
- 2. Decide the claim first: an acne treatment claim can make the product a drug, not a cosmetic.
- 3. Give salicylic acid a solvent and an acid pH, and check that it stays in solution at week four.
- 4. Set L-ascorbic acid at 5 to 15 percent at a pH near or under 3.5, in a low-oxygen pack.
- 5. Add a chelator with ascorbic acid, and expect yellowing as a sign of loss, not a style choice.
- 6. Start retinol at 0.1 to 0.3 percent, in an airless or opaque pack, with a chelator.
- 7. Tell the client to ask a doctor about retinol in pregnancy, and keep no pregnancy advice in the salon.
- 8. Recheck pH, colour and smell at week one and week four, and record what changed.

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> **Bench example: a 100 g vitamin C serum, and its limits**
>
> Water to 100 78.30; L-ascorbic acid 10.00; propanediol 5.00; glycerin 4.00; sodium hyaluronate 0.20; disodium EDTA 0.10; polysorbate 20 0.50; phenoxyethanol at the supplier dose 0.80; ethylhexylglycerin 0.10; citric acid 10 percent solution 1.00. The lines total 100.00. The target pH is 3.2 to 3.5, which is why the serum goes into an airless pump and not a dropper bottle that is opened twice a day. Make 200 g, fill four 30 g pumps, and keep one at room temperature, one at about 40 C and two in the light. Read colour and pH at day one, week two and week four. If the sample browns early, the pack or the chelator is not doing its job. Do not add fragrance to cover a change in smell; a change in smell is a result, not a marketing problem. Record every reading against the batch. A serum that is 10 percent ascorbic acid and smells of hot plastic should be discarded, not sold at a discount. The batch record and the retained sample are the only evidence of what it was.

CAUTION

No steroid, hydroquinone, mercury or tretinoin belongs in a salon formula. If a client asks for one, refuse and refer to a doctor.

Barrier ingredients and prohibited substances

Barrier ingredients are lipids and humectants that support the outer skin. Ceramides are used well under 1 percent, usually with cholesterol and fatty acids in a ratio that mimics the skin's own lipid mix. A ceramide at a pinch in water does nothing; it needs a lipid system, a fatty alcohol and a proper emulsion around it. Panthenol, glycerin and a modest occlusive such as dimethicone or a triglyceride do more for comfort at cosmetic levels than a long list of exotic extracts. The barrier is a structure, and a structure needs the right materials in the right phase, not a longer ingredient list.

Some substances are simply out of scope. Steroids, hydroquinone, mercury compounds and tretinoin are drugs or prohibited ingredients, and none of them belongs in a salon formula. A cream that lightens skin by suppressing pigment with a steroid or hydroquinone can cause thinning, streaks and rebound pigment, and mercury can cause serious systemic harm. A salon that buys a base from an unknown supplier and adds a lightening powder does not know what it is selling. If a client asks for a strong lightening product, the answer is a referral, not a formula. The same applies to any injectable or oral product.

Ingredient safety review is a separate step from formula design. The Cosmetic Ingredient Review publishes independent assessments of many cosmetic ingredients, and the supplier safety data sheet carries the handling information. Neither is a licence to use a material at any level. The market's own rules set the ceilings and the labelling duties, and the supplier sheet sets the use level for the grade you bought. When a new active arrives with a glossy brochure and no data sheet, do not weigh it. Ask for the INCI name, the safety data, the recommended level and the pH window, and keep the reply in the file.

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Patch testing and claim discipline finish the job. A patch test on a client is a screening tool, not a guarantee, and it belongs with the service record. A product that passes a patch test on ten clients can still irritate the eleventh. Keep the formula simple, keep the fragrance low or absent on a barrier product, and keep the claims to what the product does at the percent in the jar. A short ingredient list with a tested preservative and an honest claim is a better product than a long list with a dramatic claim and no evidence behind it.

- 1. Use ceramides well under 1 percent, with cholesterol and fatty acids in a supporting lipid system.
- 2. Do not put a ceramide into a water-only serum and expect a barrier effect.
- 3. Choose a modest occlusive or emollient for comfort before adding a long list of extracts.
- 4. Refuse steroids, hydroquinone, mercury compounds and tretinoin in any salon formula.
- 5. Check the INCI name and safety data for every new raw material before it is weighed.
- 6. Read the Cosmetic Ingredient Review assessment where one exists, and the supplier sheet always.
- 7. Patch test on the client, record the result, and treat a pass as a screen, not a guarantee.
- 8. Keep fragrance low or absent on a barrier product, and keep the claim to a cosmetic one.

Bench example: a barrier cream with a short ingredient list

Water to 100 72.30; glycerin 6.00; panthenol 1.00; xanthan 0.20; disodium EDTA 0.10; cetearyl alcohol 2.50; glyceryl stearate 1.50; PEG-100 stearate 1.50; caprylic/capric triglyceride 8.00; squalane 4.00; dimethicone 1.00; ceramide NP 0.20; cholesterol 0.30; phenoxyethanol at the supplier dose 0.80; ethylhexylglycerin 0.10; citric acid 10 percent solution 0.50. The lines total 100.00. The emulsifier plus fatty alcohol is 5.50 percent, inside the lotion band, and the oil phase is 19.00 percent, inside the lotion band. The ceramide is supported by cholesterol, a fatty alcohol and an oil blend, which is the only way it makes sense. There is no fragrance and no essential oil. Test at pH 5.0 to 5.5, pack in a pump, run a challenge test, and keep the claim to moisturising dry-looking skin. If the ceramide is dropped to save cost, the cream still moisturises, but the barrier claim should go with it. Keep a 20 g sample at about 40 C for four weeks, because a lipid system can separate slowly, and label the pump with the batch number and the fill date. A short list is easier to trace when a client reacts.

CAUTION

A banned substance does not become safe because the label calls it natural or professional. Refuse it and refer the client.

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CHAPTER 7

pH and measurement

What pH means in a formula

pH is a scale for the concentration of hydrogen ions, and it is logarithmic. A pH of 4 is ten times more acidic than a pH of 5, and a hundred times more acidic than a pH of 6. That is why a shift from 5.2 to 5.6 matters: it is not a small move on a linear scale, it is a large change in the chemistry that preservatives and actives depend on. The scale runs from 0 to 14, with 7 neutral, below 7 acidic and above 7 alkaline. Skin sits on the acid side, and most leave-on cosmetics are built to sit there with it.

The pH of a formula decides which form of an acid or a base is present. Organic acid preservatives such as sodium benzoate and potassium sorbate work in the acid form, so they need a product pH under about 5.5. As the pH rises, more of the acid is neutralised and the preservative effect falls, even though the same weight of material is in the jar. Ascorbic acid needs a low pH because the acid form is the active form. Salicylic acid needs an acid pH to stay dissolved and to work. A formula at the wrong pH is not a weaker version of the formula; it is a different one. The same weight of citric acid in two creams at different pH is not the same amount of free acid, and the labels do not show the difference.

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Hair and skin respond to pH physically. Hair fibre swells and the cuticle lifts when the product is alkaline, which makes hair feel rough and look dull. A shampoo at about 5.0 to 6.5 keeps the cuticle calmer than a soap-based product at 9 or 10, and the difference is visible on bleached hair within a few washes. A conditioner at about 3.5 to 5.0 helps the cuticle lie flatter, which is why conditioners are more acidic than shampoos. On skin, a leave-on moisturiser at about 4.5 to 5.5 supports comfort and the barrier, and it sits inside the working window of many preservative systems.

pH is also a moving target during making. A hot batch reads differently from a cool one, and a batch that has just been adjusted needs time to equilibrate. Measure on a sample cooled to room temperature, adjust the main batch in drops, and recheck after 24 hours. If the reading drifts, the formula is still reacting or the buffer is weak. Record both readings and the grams of adjuster used. A single number written on a sheet without a temperature, a method and a time is not a measurement; it is an impression. The impression is usually made by the person who wants the batch to pass.

- 1. Treat pH as a log scale, and remember that 0.4 of a unit is a large chemical change.
- 2. Decide the target from the product type and the active, not from a habit.
- 3. Check the preservative's pH window before choosing the target.
- 4. Measure on a sample cooled to room temperature, with a calibrated probe.
- 5. Adjust with a dilute acid or alkali in drops, stirring and rechecking after each addition.

- 6. Record the grams of adjuster and the batch weight after adjustment.
- 7. Recheck after 24 hours and record any drift.
- 8. Write the pH, the temperature and the method on the batch record.

> **Bench example: a drift that changed the preservative**
>
> A 200 g lotion is adjusted to pH 5.20 with a 10 percent citric acid solution, and the record notes 0.80 g of solution. The next morning the reading is 4.90. The operator is tempted to write 5.20 because that was the target. The honest reading is 4.90, and the drift is information: the formula may be slowly hydrolysing, the citric acid may not be buffered, or the batch may have been measured warm the first time. At 4.90 the phenoxyethanol system is still inside its window, but the organic acid booster, if there were one, would be working differently. The batch is held, the sample is re-read at 48 hours, and the next version carries a small buffer or a different adjustment. A drift of 0.30 of a unit is worth a note, not a quiet correction in the file. A second reading at 48 hours decides whether the batch is held or released. If the reading moves again at 72 hours, the batch is held for a new formula rather than patched at the bench. The client never sees the batch number, but the salon should be able to.

> **CAUTION**
>
> Do not pH a hot batch and do not record the target as if it were the reading. A drifting pH is a formula problem, not a clerical one.

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Target ranges by product

A leave-on moisturiser usually sits at about 4.5 to 5.5. That band is comfortable for skin, it supports the barrier, and it sits inside the working window of many preservative systems. A gel or serum built around ascorbic acid often sits near or under 3.5, because the acid form is the active form and the low pH is part of the product. A shampoo usually sits at about 5.0 to 6.5: low enough to keep the cuticle calmer than soap, high enough for foam and for the surfactants to behave. A conditioner usually sits at about 3.5 to 5.0, because the cuticle lies flatter in a more acidic product.

A soap-based bar or cleanser often sits at about 9 to 10. That is soap chemistry, not a mistake, but it is not a skin-friendly pH for a leave-on product and it is not where a preservative designed for an acid product will work. Do not carry a pH from one product type to another because the texture looks similar. A cream and a conditioner can look alike in a jar, and their targets are different for different reasons: the cream is built for skin, the conditioner for hair. The target follows the substrate and the chemistry, not the appearance.

The target must also fit the pack and the use. A rinse-off product at pH 6.0 has a shorter contact time and a different microbial risk from a leave-on at pH 5.0. A product in a jar that fingers enter is a harder case than a sealed pump at the same pH. If two products share a formula but not a pack, they do not necessarily share a pH target or a preservative dose. The differences are small in words and large in outcome, which is why the pack and the use belong on the formula card beside the pH.

Write the target as a band, with a lower and an upper limit, and state what happens outside it. A lotion at 4.2 may still be stable and preserved, but it may sting; a lotion at 5.8 may feel fine and still be outside the comfort band. The band is a specification, and a batch outside it is a deviation that needs a decision. Do not write a single number with no tolerance, because no bench can hit one decimal place every time, and a specification that cannot be met is not a specification. Set the band from a trial that passed, not from a supplier brochure or a competitor's jar.

- 1. Set the moisturiser target at about 4.5 to 5.5 and check it against the preservative window.
- 2. Set an ascorbic acid serum near or under 3.5, and accept the lower comfort band as part of the product.
- 3. Set a shampoo at about 5.0 to 6.5 and check the organic acid preservative at that pH.
- 4. Set a conditioner at about 3.5 to 5.0, and keep it below the shampoo's pH.
- 5. Do not use a soap pH of about 9 to 10 for a leave-on skin product.
- 6. Match the pH target to the pack and the use, not only to the texture.
- 7. Write the target as a band with a tolerance, and state the action outside it.
- 8. Record the pH of every batch against the band before filling.

> **Bench example: one base, two products, two targets**
>
> A salon makes a light base cream at pH 5.2 and wants to sell it as a face moisturiser and as a leave-in hair cream. The face product stays at 5.2, inside the 4.5 to 5.5 band, in a 50 g pump. The hair product is adjusted down to 4.2, still inside the conditioner band of 3.5 to 5.0, because the cuticle lies flatter and the combing is easier. The adjustment uses 0.60 g of a 10 percent citric acid solution on a 500 g batch, which brings the batch to 500.60 g, and the water line in the next version falls by 0.54 g. The preservative is checked at both pH values, because the same dose is not automatically right at both. The two products share a base and a batch number prefix, but they do not share a specification. The record shows the split, the weights and the two readings. If the hair cream is later raised back to 5.0, that is a new version with its own pH check, because the preservative window and the feel both move with it. A base is a starting point, not a permanent answer.

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> **CAUTION**
>
> Do not copy a pH target from one product to another because the texture is similar. The substrate and the chemistry set the band.

Measuring properly

Calibrate the meter before the batch, against fresh pH 4 and pH 7 buffers, and record the calibration. Rinse the probe with purified water between reads and blot it gently; wiping a glass probe with a tissue can scratch it and slow the response. Let the probe stabilise before reading, and stir the sample gently so the reading is representative. A meter that has not been calibrated for a month is a random number generator, especially at the acid end where the slope error is largest. A paper strip is a rough

screen only; it cannot tell 5.2 from 5.6, and that gap decides whether an organic acid preservative works.

Measure a sample, not the whole batch. Take about 5 g into a small beaker, cool it to room temperature, and measure that. The main batch stays covered and warm, and the sample is discarded or returned according to the batch record. Measuring the hot batch gives a drifting reading and risks damage to the probe. If the sample is thick, dilute it with a stated amount of purified water and record the dilution, or use a probe designed for semi-solids. An unrecorded dilution is a reading that cannot be repeated. Rinse the probe in the same purified water every time, because tap water at pH 7.8 can shift a reading by a tenth on a sensitive probe.

Adjust in drops with a dilute solution. A 10 percent citric acid solution is gentler than glacial acid and easier to add in controlled amounts. For a 200 g batch reading 5.90 with a target of 5.20, add the solution in 0.20 g drops; each drop carries 0.02 g of acid. Suppose 1.20 g of solution is needed, which is 0.12 g of citric acid and 1.08 g of water. The batch is now 201.20 g, and the water line in the next version falls by 1.08 g. Write all three numbers: the solution weight, the acid weight and the new batch weight.

Record more than the number. The record should carry the temperature, the meter or method, the calibration date, the sample weight if diluted, the adjuster strength, the grams added, and the reading after 24 hours. That is what lets another person repeat the batch or investigate a complaint. A record that says pH 5.2 with nothing else is a claim, not a measurement. The difference matters most when something goes wrong, because that is the moment when memory is least reliable and the file is most useful. A pH record with the temperature and the meter beside it takes ten seconds to write and can save a batch. A strip with a colour and no note saves nothing.

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- 1. Calibrate the meter with fresh pH 4 and pH 7 buffers and record the calibration date.
- 2. Rinse the probe with purified water between reads and blot it gently, never wipe it hard.
- 3. Take a small sample, cool it to room temperature, and measure that rather than the hot batch.
- 4. Stir the sample gently and wait for the reading to stabilise before writing it down.
- 5. If the sample is thick, use a semi-solid probe or record the dilution and its water weight.
- 6. Prepare a 10 percent citric acid solution for adjustment, and add it in measured drops.
- 7. Recheck after each addition, record the grams, and note the new batch weight.
- 8. Recheck after 24 hours, record the drift, and keep the calibration and sample notes with the batch.

Bench example: adjusting 200 g from 5.90 to 5.20

A 200 g batch reads 5.90 at 24 C after calibration against fresh buffers. The target band is 5.0 to 5.5, and the aim is 5.20. A 10 percent citric acid solution is added in 0.20 g portions with stirring, and the pH is checked after each portion. After the first portion the reading is 5.72, after the second 5.51, after the third 5.34, after the fourth 5.24 and after the fifth 5.16. The operator stops at the fourth portion, which is 0.80 g of solution and 0.08 g of acid, and accepts 5.24 as inside the band. The batch is now 200.80 g, and the water line in the next version falls by 0.72 g. The following day the reading is 5.22, which is recorded as stable. If the fifth portion had been added, the batch would need a base to come back, and each correction adds weight and another variable. If the target is 5.20 and the reading lands at 5.24, stop; the difference is inside the band and the batch is closer to the middle than a second correction would make it.

CAUTION

A meter without a calibration record is not evidence. Do not adjust a batch twice in one day without a stabilised reading between.

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CHAPTER 8

Stability, testing and claims

Stability screens

A stability screen is a set of samples held under defined conditions and read on a schedule. The usual set is a warm sample at about 40 to 45 C in the final pack, a fridge sample at about 4 C, three freeze-thaw cycles from about minus 10 C to 25 C and back, and a room-temperature control in the dark. Read them at day one, week one, week two and week four where the schedule allows. The warm sample accelerates some changes, the freeze-thaw sample tests the emulsion against expansion and contraction, and the control tells you what happens with no stress at all.

Look for specific changes, not a general impression. A water layer at the top means the emulsion is losing its structure. Oil droplets on the surface mean the emulsion inverted or was never properly homogenised. A grainy texture means a fatty alcohol or a wax crystallised during cooling. A colour change, especially yellowing or browning, points to oxidation. A smell change can mean oxidation or microbial growth. A viscosity drop, a pH drift, grittiness, or a pack that swells, softens or stains are all results. Write the reading, not the opinion: pH 5.18, no split, viscosity unchanged, faint colour is a result; stable is an opinion.

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The pack is part of the test. A formula that is stable in glass can fail in a thin PET jar, because some oils and actives stain plastic and some ingredients lose strength under light. Fill the stability samples into the jar, tube or pump you will actually sell, with the same closure and the same label. Keep one clear sample near a window if the pack is clear, because light is a stress that a dark cupboard does not reproduce. A cream that yellows in a clear jar on a shop shelf is a product that will be returned, even if the lab sample in a brown bottle is perfect.

A screen is not a proof. It catches many failures early and it is cheap, but it cannot clear a product for sale on its own. A passed screen sits beside a pH recheck, a microbial count and a challenge test. Stability can run in parallel with the challenge test, on samples from the same batch, so the two reports describe the same product. A centrifuge spin can show a weak emulsion quickly, and it is useful for comparing two trials, but it is not a substitute for time in the pack. A screen with four samples and a written schedule costs almost nothing and finds most early failures before a client does.

- 1. Fill the stability samples in the final pack, with the final closure and label.
- 2. Hold one set at about 40 to 45 C, one at about 4 C, and one at room temperature in the dark.
- 3. Run three freeze-thaw cycles from about minus 10 C to 25 C, and check after each cycle.
- 4. Read at day one, week one, week two and week four, and record numbers rather than opinions.

- 5. Check for a water layer, oil droplets, graininess, colour, smell, pH and viscosity.
- 6. Inspect the pack for swelling, softening, staining and closure damage.
- 7. Keep one control sample untouched, so a change can be compared with the original.
- 8. Treat a fail as information: change one variable, remake, and run the screen again.

> **Bench example: a four-week screen on the lotion**
>
> A 500 g lotion batch at pH 5.24 is filled into eight 50 g pumps. Two go to the warm shelf at 42 C, two to the fridge at 4 C, two to the freeze-thaw cycle and two stay at room temperature in a cupboard. At day one the readings are pH 5.24, viscosity 4200 centipoise at 25 C, white, no split, faint odour. At week one the warm samples read pH 5.19, viscosity 4000, a thin ring of water at the pump shoulder on one of them. At week two the ring is visible on both warm samples, and the room-temperature control is unchanged. At week four the warm samples have a clear water layer and the control is still white and smooth. The screen has answered a question in four weeks: the emulsifier level is marginal at 42 C. The next version raises the emulsifier by 1.00 percent, lowers water by the same, and repeats the screen before any sale. The destroyed warm sample is kept in the file as a photograph with the date, because the next person will ask what a marginal emulsion looked like. The control sample stays on the shelf beside the new batch, so a change is visible in a glance.

CAUTION

Do not call a product stable because it looked fine on the day it was made. Time and the final pack are part of the test.

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Microbial test and challenge test

A microbial count tells you what is in the batch now. A challenge test tells you how the preservative system behaves when microbes are introduced. Both matter, and they answer different questions. The count is a hygiene check on the batch: total aerobic count, yeast and mould, and a check for specified organisms. The challenge test is a performance test on the system. A batch with a low count and a weak preservative system can still fail after the client opens the jar, and a batch with a good system and a dirty process can still carry a high starting load. You need the process and the system to be right together.

Run the count on the finished product and on the water if the workshop makes its own purified water. Sample aseptically, send the sample promptly, and keep a retained sample from the same batch. A result of no growth is good; a result with a count needs a decision about the batch, the process and the cleaning record. Do not sell a batch with a count that has not been explained. Do not assume that a high preservative dose will fix a dirty process, because a high load can overwhelm a system that would otherwise pass. A count above the action level is a reason to stop, not a reason to add more preservative. The batch is quarantined while the process is checked, and the decision is written down with the date.

The challenge test follows a standard method, commonly ISO 11930, and uses a defined set of organisms. The lab inoculates the product, takes samples at set intervals, and counts survivors. The report should give the organism, the inoculum, the counts at each interval and the log reduction, not just a pass. Read the category and the criteria the lab applied. A report that says pass with no numbers cannot be used to compare two formulas or to argue a margin. Ask for the numbers, and keep them with the batch record. A pass with a thin margin against mould is a warning for a product that a client keeps in a warm bathroom.

Plan the tests before the launch, not after the first complaint. A challenge test takes weeks, and a remake after a failure takes longer. Make the batch that will be sold, fill it in the final pack, send the samples, and keep the retained sample. If the formula changes, the report no longer applies. A new fragrance, a new preservative supplier or a pH change can move the result, and the only safe assumption is that a test on a different formula says nothing about this one. That discipline is what separates a product from a trial. A salon that tests every new formula spends money once; one that skips the test spends it again on a recall.

- 1. Take an aseptic sample from the finished batch and send it for a total count, yeast and mould.
- 2. Sample the process water as well if the workshop purifies its own supply.
- 3. Keep a retained sample from the same batch, labelled with the batch number.
- 4. Send the challenge test sample in the final pack, with the actual preservative dose and pH.
- 5. Ask the lab for the method, the organisms, the counts and the log reductions, not only a verdict.
- 6. Hold the batch until both results are in, and do not sell on a verbal result.
- 7. Re-test after any change to the formula, the preservative, the pH or the pack.
- 8. File both reports with the batch record, and keep them for the market's retention period.

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> **Bench example: a count that stopped a batch**
>
> A 2 kg batch of the lotion is filled into 40 pumps. The challenge test on a previous version passed, so the operator plans to ship. The microbial count on the new batch comes back with a total aerobic count above the lab's action level and a mould count that should not be there at all. The batch is quarantined. The cleaning record shows that the mixer was rinsed but not sanitised after a batch containing a plant extract, and the water filter had passed its change date. The batch is destroyed, the mixer is cleaned and sanitised, the filter is changed, and the next batch is tested again. The preservative dose is not raised, because the system was not the problem; the process was. The record of the destroyed batch and the reason is kept, because a failure that is written down is a lesson, and one that is hidden is a repeat. The lesson is that preservation and hygiene are two controls, and one cannot cover for the other. A batch record that shows both is worth more than a clean-looking jar.

CAUTION

Do not release a batch on the strength of an old challenge test. A test belongs to one formula, one pack and one process.

Claims and records

A cosmetic claim describes what the product does for appearance or cleanliness. A drug claim describes treating, preventing or curing a disease, or affecting the structure or function of the body. The line between them is not a matter of tone. A cream can say it moisturises and helps the look of dry skin; it cannot say it cures eczema or treats acne. A shampoo can say it cleans and leaves hair easier to comb; it cannot say it kills bacteria as a product claim unless it is registered for that claim. The words decide the category, and the category decides the rules.

The United States Food and Drug Administration sets out the labelling duties for cosmetics on its cosmetics pages and in its summary of cosmetics labelling requirements. For a retail cosmetic, the label carries the identity of the product, the net quantity, the ingredient list in descending order of predominance, and the name and place of business of the firm. Warnings are added where the product needs them, for example for an aerosol or a product with a hazard in normal misuse. The FDA also explains that a product intended to treat or prevent disease, or to affect structure or function, is a drug as well as a cosmetic, and must meet both sets of rules.

Some words are best left off a cosmetic label entirely. Whitening, lightening, bleaching and permanent are claims that promise a change the product cannot lawfully deliver as a cosmetic. Chemical-free and toxin-free are meaningless when the product contains water and a synthesised ingredient, and they invite a challenge that the salon cannot answer. Antibacterial as a product claim needs a registration that most salons do not have. A softer word does not make a drug claim legal. If the owner wants a medical claim, the answer is no, with one sentence of explanation, and a referral to a clinician for the client's actual problem.

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Records are the other half of the claim. A label that says 2 percent salicylic acid should match a batch record that shows 2.00 percent, a pH that suits the acid, and a test report for that formula. A label that lists ingredients in descending order should match the percent column, with the small lines at the end. A claim that the product is preserved should match a challenge test on the same batch family. The record is what turns a statement on a jar into something the salon can defend. Without it, every claim is a guess with good typography.

- 1. Write the claim first and decide whether it is cosmetic or a drug claim.
- 2. Keep the label to cosmetic wording: moisturises, softens, helps the look of, cleans.
- 3. Put the product identity and the net quantity on the principal display panel.
- 4. List ingredients in descending order of predominance, with small lines at the end.
- 5. Put the firm's name and place of business on the information panel, and add warnings where needed.
- 6. Remove whitening, chemical-free, permanent and cure language before printing.
- 7. Match every claim to the batch record, the pH, the dose and the test report.
- 8. Keep the batch record, the label proof and the test reports together for the retention period.

Bench example: rewriting a label before print

A salon drafts a jar label for the niacinamide gel-cream. The front says Brightening and acne treatment, and the back says chemical-free, cures breakouts in two weeks. The formula contains niacinamide at 4.00 percent, water, glycerin, xanthan, an emulsifier pair, a triglyceride, dimethicone, phenoxyethanol at the supplier dose and a chelator. The label is rewritten. The front says Moisturising gel-cream for oily-looking skin. The back says Helps the look of uneven tone and keeps skin comfortable. The ingredient list follows the percent column, with water first and the preservative near the end. The name and place of business go on the information panel, with the net quantity of 50 g on the front. The words chemical-free, cure and treatment are gone. The batch record, the pH of 5.20 and the challenge test report are filed with the label proof, and the salon can now answer a question about any line on the jar. The label proof, the batch record and the test report sit in one folder, and the folder is kept for as long as the product could still be on a shelf. That is what makes the claim safe to print.

CAUTION

A cosmetic claim that promises a cure is a drug claim with a softer word. Remove it before print, not after a complaint.

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CHAPTER 9

Conditioner: the other half of the wash

Why a conditioner is not a shampoo

A shampoo removes material; a conditioner leaves material behind. The shampoo uses anionic surfactants to lift oil and soil from hair and scalp, and it leaves the cuticle slightly roughened and the fibre negative in charge. The conditioner is built to do the opposite: it deposits a thin film on the negatively charged surface, smooths the cuticle, reduces friction and makes wet comb easier. That is why the two products have different pH targets, different surfactant chemistry and different testing. A conditioner is not a shampoo with a thicker base and a different fragrance. The two products are judged by different tests and they fail in different ways.

The central chemistry is charge. Hair carries a negative surface charge, especially after washing and after colouring. A cationic conditioning agent carries a positive charge and is attracted to that surface. It adsorbs, and the film it leaves is what reduces static and drag. This is also why a conditioner must not be dumped into an anionic shampoo base: the positive and negative materials complex, the complex can drop out of solution, and the product loses both its cleaning and its conditioning. A two-in-one shampoo exists, but it is a carefully balanced system, not a mixture of two finished products.

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The pH target for a conditioner is usually about 3.5 to 5.0, lower than the 5.0 to 6.5 usual for a shampoo. A more acidic product helps the cuticle lie flatter, which is why the hair feels smoother after conditioning than after shampooing. The lower pH also sits well with the cationic agent and with many preservative systems. Do not raise a conditioner to shampoo pH for convenience, and do not lower a shampoo to conditioner pH without testing, because foam and viscosity both change with pH. A conditioner that foams like a shampoo usually carries an anionic trace, not a low pH.

A conditioner is a leave-on in practice, even when it is rinsed. Some of the film stays on the hair, and the scalp is exposed to the product every wash. That makes preservation and allergen control important, and it makes the fragrance choice a real decision rather than a finishing touch. Keep the formula simple, keep the cationic level within the supplier's range, and test the finished product on hair that has been coloured, because damaged hair adsorbs more and can feel coated when the dose is too high. A patch test on the scalp is a sensible extra step for a new conditioner, and it costs a minute.

- 1. Decide the job first: a rinse-out conditioner, a leave-in cream, or a mask, and set the target feel.
- 2. Choose a cationic agent from the supplier range, and note its active strength and pH window.
- 3. Keep an anionic surfactant out of the formula unless the brief is a tested two-in-one.
- 4. Set the pH target at about 3.5 to 5.0, below the shampoo band.

- 5. Add the fatty alcohol for body and for the cuticle film, inside the emulsifier total.
- 6. Preserve the water phase and choose a fragrance that suits a leave-on product.
- 7. Test on wet and dry hair, on untreated and on coloured hair, before a client sees it.
- 8. Run a challenge test on the finished formula in the final pack before any sale.

> **Bench example: why two finished products cannot be mixed**
>
> A salon has a shampoo at pH 5.5 with 10 percent active anionic and a conditioner at pH 4.2 with 1.50 percent behentrimonium chloride. A staff member suggests mixing equal parts to make a two-in-one. On paper the mixture has about 5 percent anionic and 0.75 percent cationic. In the beaker it turns cloudy, then separates, because the cationic and the anionic have formed a complex that is not soluble in this system. The mixture cleans poorly and conditions poorly, and the viscosity collapses. The lesson is not that two-in-ones are impossible; they are made with specific polymers and specific ratios that have been tested. The lesson is that a salon cannot create one by pouring two bottles together. Record the failed trial and keep the two products separate, with their own pH targets and their own batch records. If a client asks for a two-in-one, sell a tested one or sell two products; do not make one in the back room. The failed trial cost two bottles and taught the staff more than a page of theory. The two bottles stayed on the shelf as a reminder.

CAUTION

Never pour a conditioner base into an anionic shampoo. The charges complex, the product clouds or splits, and both jobs are lost.

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Cationic systems and fatty alcohol

The common cationic conditioning agents include behentrimonium chloride, cetrimonium chloride and behentrimonium methosulfate. Each has a supplier range, often around 1 to 3 percent of the raw material in a rinse-out conditioner, and each has a pH window. The active strength matters: a 30 percent solution at 5.00 g is 1.50 g of active, while a 75 percent paste at 2.00 g is also 1.50 g. Write the strength beside the weight, exactly as for a surfactant. A conditioner that is too thin usually has too little cationic or too little fatty alcohol, and a conditioner that is too heavy usually has too much of both.

Fatty alcohol gives the conditioner its body and helps the cationic film spread evenly. Cetearyl alcohol at about 2 to 4 percent is common in a rinse-out conditioner, and it is counted with the emulsifier rather than as a separate emulsifier. The alcohol also raises the melt point, so the phase must be heated to about 70 to 75 C until it is fully clear. A conditioner made with unmelted fatty alcohol feels gritty and looks pearly in the wrong way. Cool slowly with gentle stirring, because fast cooling can crystallise the alcohol into visible grains. Keep the two phases within about 10 C at the combine, as for any emulsion.

Over-conditioning is a real fault, and it shows as limp, coated hair that holds no shape. It comes from too much cationic, too much silicone, or a product left on too long. Damaged and bleached hair

adsorbs more, so a dose that feels light on virgin hair can feel heavy on a client with a recent colour. Build the base at the lower end of the cationic range, test on both hair types, and let the testers tell you which way to move. The client's hair is the specification, but only after the formula is stable and preserved. A tester with very fine hair will notice a heavy film sooner than a tester with thick hair.

Cationic agents also interact with the preservative system and with anionic traces. A batch made in a vessel that was rinsed but not cleaned after a shampoo can carry enough anionic residue to cloud the conditioner. A preservative that works in a lotion may partition differently in a cationic system. Test the actual formula, not a similar one. When a conditioner turns cloudy a day after making, the first suspects are an anionic residue, an incompatible fragrance, and a cationic level above its solubility in this system. A cloudy conditioner is not a texture choice; it is a fault to be explained.

- 1. Choose the cationic agent and read its active strength, pH window and recommended level.
- 2. Calculate the active matter, and write it in the notes rather than the percent column.
- 3. Add cetearyl alcohol at about 2 to 4 percent for body and film support.
- 4. Heat phases A and B to about 70 to 75 C until the fatty alcohol is fully melted.
- 5. Combine with gentle stirring and cool slowly to avoid crystallising the alcohol.
- 6. Add the preservative and fragrance under 40 C, at the supplier's allowed temperature.
- 7. Check pH in the 3.5 to 5.0 band, and record the reading and the adjuster weight.
- 8. Test on wet and dry hair, and lower the cationic or the silicone if the hair feels coated.

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> **Bench example: a 100 g rinse-out conditioner**
>
> Water to 100 86.40; cetearyl alcohol 3.00; behentrimonium chloride 1.50; glyceryl stearate 0.80; caprylic/capric triglyceride 2.00; dimethicone as the supplier dilution 1.50; glycerin 3.00; panthenol 0.50; phenoxyethanol at the supplier dose 0.80; ethylhexylglycerin 0.10; citric acid 10 percent solution 0.40. The lines total 100.00. The cationic is 1.50 percent of the raw material, which at a 30 percent solution is 0.45 percent active, inside the supplier range for a rinse-out. Heat phases A and B to about 72 C, combine, and cool slowly. Add the preservative and the citric acid under 40 C, and check the pH at about 4.2. The formula has no anionic surfactant, so the cationic can do its job. Test on wet comb and on dry feel, and keep a sample at 40 C for four weeks. The citric acid solution is a starting charge; record the actual grams used and reduce the water line in the next version by the water that came with it. A conditioner that is perfect on day one and thin at week two is a formula that needs more fatty alcohol, not more fragrance.

> **CAUTION**
>
> Do not double the cationic to make a conditioner feel richer. Above its useful level it coats the hair, irritates the scalp and can cloud the batch.

pH, silicones and the rinse-off test

The pH of a conditioner is a performance decision. At about 3.5 to 5.0, the cuticle lies flatter and the surface feels smoother. At 5.5 or above, some of that smoothness is lost and the product starts to

behave like a shampoo with a conditioning agent in it. The lower pH also affects the preservative, so the system must be chosen for the band the product will actually sit in. Measure pH on a cooled sample, adjust with a dilute acid in drops, and record the grams. A conditioner adjusted warm and filled without a recheck is a product with an unknown pH.

Silicones are useful and easy to misuse. Dimethicone and amodimethicone are usually supplied as emulsions or dispersions, and the percent on the card refers to the supplied material, not to the neat silicone. A supplier dilution at 1.50 percent might carry only 0.45 percent of silicone. Do not weigh neat silicone into a water formula and expect it to disperse; it will bead, cloud the batch and leave an oily ring. Use the supplier's dilution, at the supplier's level, and write the dilution in the notes. A silicone that is not dispersed is a complaint in a bottle. If the supplier gives no dilution, ask for one before the batch, not after.

The rinse-off test is the only test that matters for the feel. Wash a hair swatch with the salon shampoo, apply a fixed weight of conditioner, leave it for the stated time, and rinse for a fixed time. Comb it wet, then dry it and comb again. Do this on untreated hair and on hair that has been coloured, because the two behave differently. Record the weight applied, the time and the result in plain words. A conditioner that is tested only on one head of hair is a sample, not a product. Take a photograph of the swatch and keep it with the record.

Stability for a conditioner follows the same pattern as a cream: warm, cold, freeze-thaw and a control, in the final pack. Watch for separation, graininess, a change in viscosity, a change in pH, and a change in smell. A conditioner that thins after two weeks usually has too little fatty alcohol, a cationic level that is marginal, or a pH drift. A conditioner that grains has been cooled too fast or has too much fatty alcohol for the system. Neither fault is fixed by fragrance. A conditioner that has separated has failed, and no amount of shaking will restore the film.

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- 1. Set the pH band at about 3.5 to 5.0 and confirm the preservative works in that band.
- 2. Measure pH on a cooled sample and adjust with a 10 percent citric acid solution in drops.
- 3. Use silicone only as the supplier dilution, and record the dilution and the supplied percent.
- 4. Disperse the silicone fully during cool-down, below 40 C, with steady stirring.
- 5. Wash a swatch with the salon shampoo, apply a fixed weight of conditioner, and time the contact.
- 6. Rinse for a fixed time, comb wet, dry, and comb again, and write the result in plain words.
- 7. Repeat on coloured hair, because damaged hair adsorbs more and feels heavier.
- 8. Run the four-week stability screen and a challenge test before the product is sold.

Bench example: a silicone that would not disperse

A 200 g conditioner trial is made with 3.00 g of a dimethicone emulsion at 50 percent, added at 38 C with slow stirring. The batch clouds and a thin oily film appears on the surface after an hour. The operator had weighed the emulsion correctly, but the batch had been stirred with a paddle that did not reach the bottom, so the silicone sat in a layer. The batch is discarded, and the next trial uses the same weight with a propeller stirrer for five minutes at low speed, then a slow cool. The cloud clears, the film does not return, and the wet comb is smooth. The record notes the stirrer, the speed and the time, because the fault was in the process and not in the formula. A conditioner that looks fine in the beaker can still fail in a 200 ml bottle if the silicone was never dispersed. The fix was mechanical, and it cost one batch to learn; the next batch carried the lesson in the process note. A process note is cheaper than a second failure.

CAUTION

Never weigh neat silicone into a water phase. Use the supplier dilution and record it, or the batch will bead and cloud.

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CHAPTER 10

Antioxidant and preservative: two different jobs

Two different spoilage routes

A cosmetic can spoil in two ways, and the two are often confused. Oil spoils by oxidation: oxygen attacks the unsaturated fats, the oil develops a rancid smell, and the colour may darken. Water spoils by microbial growth: bacteria, yeast and mould multiply in the water phase and can make the product unsafe. An antioxidant addresses the first. A preservative addresses the second. Tocopherol is an antioxidant, and it does nothing to stop microbes. Phenoxyethanol is a preservative, and it does nothing to stop rancidity. A formula needs the one that matches its risk, and a formula with both oil and water needs both.

The confusion is common because both problems show up as a change in smell. A rancid oil smells stale and crayon-like. A contaminated cream can smell sour, yeasty or simply wrong. The nose cannot tell you which route caused the change, and by the time the smell is obvious the product may already have been sold. That is why the tests are separate: an accelerated stability screen looks at oxidation and physical change, and a microbial count or challenge test looks at growth. Neither test substitutes for the other, and neither is replaced by a smell check. Write the two tests as two lines in the plan, with different sample dates.

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Water activity decides how much a water phase can support growth, and oil content does not change that. A cream that is 25 percent oil still has a continuous water phase, and that water is where microbes live. A water-in-oil cream is different, because the water sits in isolated droplets, but a breach in the film can still let organisms in. The practical rule for a salon is simple: if water is present and the client will open the pack, a preservative system is required, whatever the oil percentage says on the front of the jar. The oil percentage is a texture number, not a preservation number.

Essential oils are not preservatives. Tea tree, rosemary and similar oils have some antimicrobial activity in a test tube, but at cosmetic levels in a real formula they do not deliver a preserved product, and they add allergens. A product preserved with essential oils alone is a product with a scent and an unmanaged risk. The same applies to grapefruit seed extract and to the many natural preservative blends sold without data. If the supplier cannot give a dose, a pH window and a challenge test report, the material is a fragrance or a marketing ingredient, not a preservative. A scent is not a system, and a label that implies otherwise is a claim the salon cannot support.

- 1. Identify the risk first: oxidation for an oil, microbial growth for a water phase.
- 2. Add an antioxidant such as tocopherol for the oil, at about 0.05 to 0.50 percent.
- 3. Add a preservative system for the water, at the supplier dose inside the legal ceiling.

- 4. Do not count tocopherol, essential oils or plant extracts as preservatives.
- 5. Do not count a preservative as protection against rancidity.
- 6. Test the two risks separately: stability for oxidation, count and challenge for microbes.
- 7. Write both systems on the card with their doses and their reasons.
- 8. Re-test when an oil, a water content or a pack changes.

> **Bench example: an anhydrous oil that needs only one system**
>
> A facial oil is made from caprylic/capric triglyceride 56.00, squalane 24.00, jojoba oil 10.00, dimethicone 5.00, isopropyl myristate 4.00, tocopherol 0.50 and bisabolol 0.50. The lines total 100.00, and there is no water in the formula. No preservative is needed for microbial growth, because there is no water phase and the pack is a dropper that does not admit water in normal use. Tocopherol at 0.50 percent is there to slow oxidation of the jojoba and the squalane, and the batch is filled into a dark glass bottle with a small headspace. The same oil with 2 percent aloe water added would need a preservative and a challenge test, because the water would create a growth route that the tocopherol cannot touch. One added line changes the whole risk profile, and the card must show it. The tocopherol level stays the same, because it protects the oil and not the water. The preservative is chosen from the supplier sheet, kept inside the legal ceiling, and proved by a challenge test in the dropper bottle. A shampoo or a cream with the same oil would need the same two systems, and the records would have to show both.

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CAUTION

Tocopherol is not a preservative and a preservative is not an antioxidant. A product that needs both must carry both, each at its own dose.

Tocopherol, chelators and the oil phase

Tocopherol is used at about 0.05 to 0.50 percent in the oil phase, and it works by being oxidised itself before the oil is. It is a sacrificial material, so its level falls over time and the protection falls with it. Add it to the oil phase before the emulsion forms, so it is distributed through the droplets rather than sitting in a few of them. A water-soluble antioxidant such as sodium metabisulfite is a different tool and is not a substitute; it has its own sensitiser and regulatory issues. Choose the antioxidant for the phase it has to protect, and record the level.

Antioxidants work better in company. A chelator such as disodium EDTA at about 0.10 percent binds trace metals that catalyse oxidation, and it supports the preservative at the same time. A synergist such as ascorbyl palmitate can regenerate tocopherol to some extent, and a plant extract with a declared antioxidant content can add to the effect if the supplier gives a use level. None of these is a guarantee. An oil with a high polyunsaturated content will still oxidise, and heat, light and air will speed it up. The antioxidant slows the process; it does not stop it. A screen that shows a colour change at week two is telling you the antioxidant is losing.

The oil phase itself is the largest variable. A refined triglyceride is more stable than an unrefined seed oil, and a seed oil rich in linoleic acid is more fragile than squalane. If the brief calls for a fragile oil, the

formula needs a stronger antioxidant, a smaller headspace, and a pack that excludes light. A clear jar on a shop shelf is a stress test that no antioxidant can fully pass. The supplier's recommended level for the oil is a starting point, and the stability screen is the judge. If the supplied oil is already old, no antioxidant in the formula will rescue it.

Temperature is the enemy in the workshop as well as on the shelf. A long hot hold oxidises oils before the product is even bottled, and a batch that is heated twice is worse than one heated once. Melt the oil phase, combine, and cool without unnecessary delay. If a batch has to be reheated to add a missed line, record it, because the oil has already been stressed and the shelf life may be shorter. A formula that is only stable when it is made perfectly is not stable enough for a salon. Heat once, cool once, and write the temperatures down.

- 1. Add tocopherol at about 0.05 to 0.50 percent to the oil phase, before the emulsion forms.
- 2. Keep the chelator at about 0.10 percent, and count it as support for both systems.
- 3. Choose the antioxidant for the oil's fragility, not for the label story.
- 4. Reduce headspace and exclude light if the oil is high in polyunsaturates.
- 5. Avoid long hot holds and never reheat a batch without recording it.
- 6. Store the raw oil under the supplier's conditions, and check the date before use.
- 7. Test the finished product for smell, colour and viscosity at week one and week four.
- 8. Replace the antioxidant if the oil or its supplier changes, and re-run the screen.

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Bench example: a lotion with a fragile oil

The standard lotion card carries 6.00 percent caprylic/capric triglyceride and 0.10 percent tocopherol. A client asks for a version with 5.00 percent unrefined rosehip oil, which is rich in linoleic acid. The oil replaces 5.00 g of the triglyceride, and the water line falls by 5.00 g to keep the total at 100.00. Tocopherol is raised to 0.50 percent, disodium EDTA stays at 0.10 percent, and the pack changes from a clear jar to an opaque pump. The batch is made once, without a reheat, and filled with a small headspace. At week four the warm sample is slightly darker than the control, which is recorded as an early sign of oxidation. The next version drops the rosehip to 2.00 percent and adds 3.00 percent of a stable triglyceride, because the client wants the story but the product has to survive the shelf. The screen, not the brochure, decides how much of a fragile oil the formula can carry. If the screen is marginal, lower the fragile oil before you raise the antioxidant again, because the oil is the source of the problem and the antioxidant is only the brake. Keep the two trial jars side by side and read them at the same hour of the same day.

CAUTION

An antioxidant slows oxidation; it does not make a fragile oil stable in a clear jar. Change the pack or lower the oil if the screen fails.

Pack, dose and what a smell test cannot tell you

The pack decides how much protection the formula needs. A jar that fingers enter is inoculated every time it is opened, and the product at the surface is exposed to air, light and bathroom humidity. A pump or an airless pack keeps the bulk away from fingers and air, so the same formula can carry a lighter system and a longer shelf life. A clear pack adds light to the stress, and a large headspace adds air. When a formula is moved from a pump to a jar, the preservative and the antioxidant both deserve a second look, and the challenge test should be repeated in the new pack.

A swelling pack is a signal, not a cosmetic problem. Gas produced by microbial growth can bulge a tube or lift a lid, and a fermented or contaminated product can build pressure. A pack that softens or stains may be reacting with the formula, which is a compatibility problem between the product and the plastic. A split phase, a water layer or oil on the surface means the emulsion has failed. None of these is fixed by shaking the bottle before use. Each is a reason to quarantine the batch and look at the record, the pack and the process.

A one-week smell check is not a microbial test. It can detect a strong spoilage odour, but many contaminated products smell normal for weeks, and a product with a fragrance can mask a change entirely. A clear product can carry a high count, and a cloudy product can be perfectly safe. The only way to know is a count and a challenge test. The smell check is useful as an early warning for oxidation in an oil, where the change is often detectable before the colour moves, but even there it is a screen, not a result. A smell check that passes tells you almost nothing about the count.

Write the pack and the test into the batch record together. The record should name the pack type, the fill date, the preservative dose, the antioxidant dose, the challenge test report number and the stability readings. When a complaint arrives, those five facts let the salon find the batch and decide what to do. Without them, the salon can only guess, and a guess that reaches a client is worse than no answer. The pack is part of the formula, and the test is part of the proof. A file that holds the pack, the dose and the report together is worth more than a shelf of samples with no labels.

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- 1. Match the pack to the risk: airless or pump for fragile actives, jar only with a stronger system.
- 2. Count the pack change as a formula change, and re-test when the pack changes.
- 3. Check for swelling, softening, staining and a loose closure at every stability read.
- 4. Treat a split phase or a water layer as a fail, and quarantine the batch.
- 5. Do not shake a separated product and sell it; the separation will return.
- 6. Use a smell check only as an early warning, never as a microbial result.
- 7. Record the pack type, fill date, doses and test report number with the batch.
- 8. Keep a retained sample in the same pack, so a complaint can be compared with the original.

Bench example: a jar that swelled

A 100 g moisturiser is filled into 60 g jars and sold over eight weeks. At week six a client returns a jar with a domed lid and a sour smell. The batch record shows pH 5.20, phenoxyethanol at 0.80 percent, ethylhexylglycerin at 0.10 percent, and a challenge test report for the pump version of the same formula. The jar version was never tested in its own pack. The remaining jars are recalled, the batch is quarantined, and a count is ordered. The count shows yeast, and the investigation finds that the jars were filled by hand from an open bucket while the salon was also doing a colour service. The preservative was not the only fault, but the pack made it worse. The next version is filled from a closed container, in a pump, with its own challenge test, and the jar is withdrawn from sale. The salon now fills only in the tested pack, and the record shows the pack beside the dose, so the next person cannot repeat the mistake by choosing a jar. The client was told what happened, and the salon paid for the return without argument.

CAUTION

A smell test, a clear look and a sealed lid are not proof of preservation. Only a count and a challenge test in the final pack are.

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CHAPTER 11

Reading a label the way a formulator does

Five things a label must carry

The United States Food and Drug Administration publishes a summary of cosmetics labelling requirements, and the first lesson from it is that a label is a short, structured document rather than a design. For a cosmetic sold at retail, the principal display panel identifies the product and states the net quantity. The information panel carries the name and place of business of the firm, the ingredient list in descending order of predominance, and any warnings the product needs. The FDA cosmetics pages set the wider frame: what a cosmetic is, what makes it a drug as well, and why a false or misleading label can make a product misbranded.

The statement of identity tells the buyer what the product is. It may be a common name such as body lotion, a descriptive name, or a name the public understands, and it should be in bold type of a sensible size. The net quantity tells the buyer how much is in the pack, in weight, measure or count, placed in the lower part of the panel. A 50 g jar and a 50 ml bottle are not the same amount of product, because the density is different, which is why the unit matters and why a cream is usually declared by weight. Neither line is decoration; each answers a question the buyer is entitled to ask.

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The ingredient list is the part a formulator reads first. Ingredients are declared in descending order of predominance, so the largest amount comes first and the smallest last. Colour additives and ingredients present at 1 percent or less may be listed without regard to order, which is why the last few lines are often a cluster of preservatives, fragrance and actives. Fragrance may be declared collectively. The names should be the ones established or adopted by regulation, and INCI names are widely used. If the list does not match the batch record, one of the two is wrong, and the salon should find out which before the next batch is made.

The name and place of business identify who stands behind the product, with a street address, city, state and postcode, or a qualifying phrase such as manufactured for or distributed by when the named firm is not the maker. Warnings appear where the product needs them, for example on an aerosol or a product with a hazard in normal misuse. A cosmetic that has not been shown to be safe also carries a specific warning statement under the FDA rules. Five items, one page, and a formulator who can read them can tell whether a label is complete before it goes to print.

- 1. Find the statement of identity and check that it describes the product in plain words.
- 2. Find the net quantity and check that the unit suits the product: weight for a cream, volume for a liquid.
- 3. Read the ingredient list from the top and compare the first five lines with the percent column.

- 4. Check that the small lines at the end are plausible: preservative, fragrance, actives, colour.
- 5. Find the firm's name and place of business, and the qualifying phrase if it is not the maker.
- 6. Look for warnings where the product type needs them, and check that they are legible.
- 7. Compare the label's ingredient order with the batch record, and resolve any mismatch.
- 8. Keep a proof of the printed label with the batch record before the first fill.

> **Bench example: reading a jar against its batch record**
>
> A 50 g jar of face cream reads: Moisturising Face Cream, 50 g, and on the back, Aqua, Glycerin, Caprylic/Capric Triglyceride, Cetearyl Alcohol, Glyceryl Stearate, PEG-100 Stearate, Dimethicone, Panthenol, Xanthan Gum, Phenoxyethanol, Ethylhexylglycerin, Tocopherol, Citric Acid, and the firm's name and address. The batch record reads water 77.20, glycerin 5.00, triglyceride 6.00, cetearyl alcohol 2.00, glyceryl stearate 1.50, PEG-100 stearate 1.50, dimethicone 1.00, panthenol 1.00, xanthan 0.20, phenoxyethanol 0.80, ethylhexylglycerin 0.10, tocopherol 0.10, citric acid solution 0.50. The orders match, and the small lines sit at the end. If the label had listed phenoxyethanol third, the record and the label would disagree, and the printed stock would have to be withdrawn. The label is a public summary of the record, and the two should be read side by side. A label proof that carries the batch number in the file makes the comparison possible years later, when nobody remembers which artwork was printed. Read the front, the back and the base of the jar, because the five items are not all in one place. A label with a beautiful front and a missing address is an incomplete label.

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> **CAUTION**
>
> Never print a label from a draft formula. Compare the ingredient order with the batch record that was actually made, not with the one that was planned.

Cosmetic claim versus cure claim

The FDA defines a cosmetic as an article intended to be applied to the body for cleansing, beautifying, promoting attractiveness or altering appearance, without affecting structure or function. A product intended to treat or prevent disease, or to affect the structure or function of the body, is a drug as well, and must meet both sets of rules. That single sentence explains most of the claim discipline in this book. A moisturiser that helps the look of dry skin is a cosmetic. A cream that cures eczema is a drug, whether or not the word cure appears, because the intent is to treat a disease.

The same logic covers acne, pigmentation and infection. A product that helps the look of oily, blemish-prone skin is making a cosmetic claim. A product that treats acne is making a drug claim. A product that helps even the look of tone is cosmetic; one that removes melasma is treating a condition. A shampoo that cleans hair is cosmetic; one that treats dandruff is a drug in many markets, which is why antidandruff shampoos are often regulated as over-the-counter products. The words are not a style choice. They decide which rules apply, and the rules decide what testing and labelling are needed.

A claim must also be true for the formula. A moisturiser that is mostly water with no occlusive or humectant at a useful level does not help dry skin for long, even if the words are cosmetic. A serum with 0.10 percent of an active that is studied at 5 percent is making a claim the formula cannot support. The FDA pages note that a product may be considered misbranded if its labelling is false or misleading, and a claim that outruns the formula is exactly that. Write the claim from the percent column, the pH and the test results, not from the competitor's website. A claim that outruns the formula is false or misleading labelling, whatever the intention behind it.

When a client or an owner asks for a stronger claim, the answer is a rewrite, not a softer word. Cures acne becomes helps the look of oily, blemish-prone skin. Cures eczema becomes moisturises dry, itchy-looking skin. Removes melasma becomes helps even the look of skin tone. Whitening becomes a description of what the product actually does, or nothing at all. Each rewrite must still be true. If the formula cannot support even the cosmetic version, the honest answer is that the product does not do the job, and the formula should change before the label does. A label that is rewritten to be honest about a weak formula is still a weak product, and the client will find out.

- 1. Write the claim in one sentence, then decide whether it is cosmetic or a drug claim.
- 2. Check the claim against the FDA definition: appearance only, or structure and function.
- 3. Check the claim against the percent column, the pH and any test results.
- 4. Rewrite cure and treat language into cosmetic language that the formula supports.
- 5. Remove disease names from the label, the website and the staff script.
- 6. Keep staff scripts consistent with the label, because a spoken claim is still a claim.
- 7. Refuse a medical claim and refer the client to a clinician when the concern is medical.
- 8. Keep the final wording, the proof and the reason for any change with the batch file.

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> **Bench example: one product, three drafts of a claim**
>
> A salon makes a 2 percent salicylic acid leave-on lotion at pH 3.8 for oily-looking skin. Draft one says Treats acne and clears blackheads. That is a drug claim, and in many markets the product would need drug approval, which the salon does not have. Draft two says Removes acne in seven days. That is worse, because it adds a timeframe the formula cannot prove. Draft three says Helps the look of oily, blemish-prone skin, and the label keeps the salicylic acid at 2 percent or below with the local limit checked. The third draft is cosmetic, and it is still true only if the product is used as directed and the client does not have a medical condition. The staff script carries the same wording, so the claim at the shelf and the claim at the chair match. The salon also writes the reason for rejecting the first two drafts in the file, so the next person does not bring them back. A claim that has been considered and refused is a decision; a claim that was never noticed is a risk.

CAUTION

A softened word does not turn a drug claim into a cosmetic one. If the intent is to treat a disease, the product is a drug.

Words to leave off the label

Whitening is a word to leave off. It promises a change in skin colour that a cosmetic cannot lawfully deliver, and in many markets it is treated as a medicinal claim. The same applies to lightening, bleaching and permanent. Even brightening deserves care: it can describe the look of tone, but it should not imply a change in the amount of pigment. If the formula contains niacinamide at 4 percent and a humectant system, the honest claim is about the look of uneven tone. A client who expects a different skin colour will be disappointed, and a regulator who reads the word whitening will ask a question the salon cannot answer.

Chemical-free and toxin-free are words to leave off, because they are not true of a product that contains water and a synthesised ingredient. Water is a chemical. A preservative is a chemical. A fragrance is a mixture of chemicals. The phrase is a marketing device that trades on fear, and it invites the obvious reply: which chemicals are absent, and at what limit. A better label describes what is in the product and what it does. Free-from claims about specific allergens can be useful when they are true and tested, but a general chemical-free claim is a claim with no content.

Other words to avoid include permanent, which no cosmetic can guarantee; antibacterial as a product claim, unless the product is registered for it; and dermatologist tested, unless there is a report and a named dermatologist behind it. Clinically proven is a drug-flavoured claim that needs evidence the salon does not have. Natural is not regulated in the same way everywhere, and a product with a synthesised preservative is not natural in any useful sense. None of these words improves the product. Each one creates a question that the batch record cannot answer. A longer list of forbidden words is easy to find, but the principle is shorter: if the formula cannot show it, the label cannot say it.

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The practical test is simple: read the label as if you were the person who will complain. Does each claim describe something the formula does, at the level in the jar, with the tests in the file? If not, remove it. A shorter label with a modest claim is easier to defend and easier to sell honestly. The salon's reputation is built on the gap between the promise and the result, and a small promise that is kept is worth more than a large one that is not. Read the label aloud before it is printed, because a sentence that sounds like an advertisement often sounds like a claim when spoken.

- 1. Remove whitening, lightening, bleaching and permanent before the artwork is approved.
- 2. Remove chemical-free and toxin-free, and describe what the product contains instead.
- 3. Remove cure, treat, heal and repair when they refer to a disease or a medical condition.
- 4. Remove antibacterial as a product claim unless the product is registered for it.
- 5. Remove clinically proven and dermatologist tested unless a report exists and is filed.
- 6. Replace each removed word with a cosmetic claim the formula can support.
- 7. Check the website, the shelf card and the staff script, not only the jar.
- 8. Keep the final artwork and the reason for each change with the batch record.

Bench example: cleaning up a shelf card

A shelf card reads: Whitening cream, chemical-free, removes dark spots in 14 days, dermatologist tested. The product is the niacinamide gel-cream at pH 5.2 with a tested preservative. Four claims have to go. Whitening becomes helps even the look of skin tone. Chemical-free is deleted. Removes dark spots in 14 days becomes helps the look of uneven tone with regular use, and the timeframe goes, because the salon has no study. Dermatologist tested is deleted, because there is no report. The card now says less, and every remaining word can be matched to the formula and the file. The staff are briefed on the new wording, because a spoken claim can undo a careful label. The old cards are collected and destroyed rather than left in a drawer. A staff briefing takes ten minutes and prevents the shelf card from being contradicted at the chair. The new wording is also checked against the website, because the page is part of the labelling in practice. A client who reads the website and then the card should find the same promises in both places.

CAUTION

Do not keep an old shelf card because it sells better. A claim that cannot be defended is a liability with a laminate finish.

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CHAPTER 12

Packaging and the shelf

Matching the pack to the formula

The pack is part of the formula, because it decides what the product meets after it leaves the bench. Air, light, fingers and heat all reach the product through the pack, and each one changes the rate of spoilage. An airless pump keeps the bulk away from air and from fingers. A jar invites both. A clear bottle admits light. A dark bottle with a small headspace admits much less. A tube protects the product until it is opened, and then the nozzle becomes the route in. The same lotion can be stable for two years in one pack and fail in eight weeks in another, with no change to a single line of the formula.

Compatibility is the second question. Some oils and actives stain plastic, some solvents soften it, and some fragrances attack a particular resin. A pack that softens, crazes or stains is not a cosmetic problem; it is a material problem that can also contaminate the product. Ask the supplier for the resin and for compatibility data, and test the actual formula in the actual pack. A drop test and a four-week fill test catch most of these faults before a client does. If a pack is changed for cost or for looks, treat it as a formula change and re-run the stability screen.

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The dispensing route matters as much as the material. A pump that delivers a large dose wastes product; one that delivers a small dose makes the client pump five times and introduces more air. A dropper lets the client touch the tip and the product. A wide jar is easy to use and hard to keep clean. A tube is good for a cream that is used on hands, and poor for a serum that needs a measured dose. Choose the pack for the way the product will be used, then test the preservative system in that pack, because the use pattern is part of the microbial challenge.

Cost, appearance and shelf presence are real constraints, but they come after function. A beautiful jar that lets the cream oxidise is a return waiting to happen. A cheap pump that jams is a complaint. The right pack is the cheapest one that protects the formula for the intended life, dispenses the right dose, and can be filled cleanly in the salon's actual process. That is a short list, and it is worth more than a long list of finishes. A pack that works is invisible to the client; a pack that fails is the only thing they remember. Write the fill and closure checks into the batch record, so the pack is verified with the same care as the pH.

- 1. List what the formula is sensitive to: oxygen, light, water loss, fingers, heat.
- 2. Choose the pack that limits the biggest sensitivity first, then the others.
- 3. Ask the supplier for the resin and for compatibility data with oils, solvents and fragrance.
- 4. Fill a trial batch in the actual pack and hold it for four weeks before ordering stock.
- 5. Check the dose the pack delivers, and compare it with the intended use.

- 6. Test the pack for softening, crazing, staining and closure damage.
- 7. Treat a pack change as a formula change, and re-run the stability screen.
- 8. Record the pack type and the supplier lot with the batch record.

> **Bench example: the same serum in three packs**
>
> A 10 percent ascorbic acid serum at pH 3.3 is filled into a clear dropper bottle, an amber dropper bottle and a 30 g airless pump. All three hold the same batch. At week one the clear bottle is pale yellow, the amber bottle is unchanged and the pump is unchanged. At week four the clear bottle is brown and smells stale, the amber bottle is light yellow, and the pump is still pale. The formula did not change; the pack did. The salon sells only the airless pump, and the amber bottle is kept for a short-life trial that is made weekly. The clear bottle is removed from the range, even though it was the cheapest and looked the best on the shelf. The batch record lists the pack beside the batch number, so the result can be traced. The formula was not the variable, and the test showed it. A pack trial with three candidates costs less than a recall and answers the question faster than an argument about supplier quality. Keep the three packs labelled with the batch and the fill date, and read them on the same day.

CAUTION

Do not choose a pack for its look before the formula has been tested in it. A beautiful pack cannot protect an unstable product.

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Airless, dark and the actives that need them

Vitamin C and retinol are the two actives that most often demand an airless pack. L-ascorbic acid at 5 to 15 percent and a pH near or under 3.5 is unstable in the presence of oxygen, and it yellows as it oxidises. Retinol at 0.1 to 0.3 percent is sensitive to both air and light, and it degrades faster in a jar that is opened twice a day. An airless pump keeps the bulk away from air until the moment of use, and a dark or opaque pack removes light. Together they buy time that no antioxidant can buy on its own.

An airless pack is not a pump with a nice name. It uses a piston or a bag that collapses as product is drawn, so the volume behind the product does not fill with air. A conventional pump pulls air back into the bottle to replace what was dispensed, and that air is the enemy. A dropper is worse, because every opening exchanges the headspace. When a supplier offers an airless pack, ask how it works and test the dose. A pack that is airless but delivers 2 g per stroke is wasteful, and a pack that delivers 0.1 g makes the client work too hard and introduces air at the nozzle.

Dark glass, opaque plastic and a small headspace all reduce light and oxygen exposure. A clear bottle with a coloured label is not a dark pack, because the light reaches the liquid at the edges. A bottle that is filled to the shoulder has less headspace than one filled halfway, and less oxygen to react with. If the product is a water-based serum with ascorbic acid, a chelator such as disodium EDTA at about 0.10 percent is part of the protection, because trace metals catalyse the oxidation. The pack, the chelator and the pH work as a system, and the stability screen tests the system.

The pack also sets the shelf life claim. A product in an airless pack can carry a longer period after opening than the same product in a jar, and the label should reflect what was tested, not what would be convenient. If the salon cannot afford the airless pack, the honest answer is a smaller jar, a shorter shelf life and a clear instruction to use it within a stated time. What the salon must not do is put an unstable serum in a clear dropper and sell it with a two-year claim because the label looks better that way.

- 1. Identify the actives that are sensitive to oxygen or light, and list them before choosing a pack.
- 2. Choose an airless or opaque pack for ascorbic acid and retinol, and test the dose it delivers.
- 3. Reduce the headspace at fill, and check that the closure seals without trapping air.
- 4. Add a chelator at about 0.10 percent when the formula contains ascorbic acid.
- 5. Keep the pH in the range the active needs, and record it for every batch.
- 6. Fill a trial in the actual pack and read colour and smell at week one and week four.
- 7. Set the period after opening from the test, not from the competitor's label.
- 8. Tell the client how to store and use the pack, and put that instruction on the label.

> **Bench example: a retinol cream that needed a different pack**
>
> A 30 g retinol night cream at 0.20 percent is first filled into a clear jar, because the client likes to see the cream. At week two the cream at the surface is slightly darker, and at week four the smell has changed and the colour is uneven. The formula is remade with the same percentages, filled into an opaque airless pump, and held for four weeks beside the jar. The pump sample is unchanged at week four, while the jar sample is clearly oxidised. The salon switches the pack and shortens the period after opening from twelve months to six, because that is what the test supports. The formula did not change, but the product did. A retinol product in a clear jar is a product that is already losing its active on the shelf. The client liked the jar, and the client also liked the result; the second one is what keeps the sale. Write the pack, the period after opening and the storage instruction on the label. A client who keeps the pump in a hot car has changed the conditions the test covered, and the instruction is the only warning they will get.

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CAUTION

An airless pack is not a substitute for a stable formula. Test the formula in the pack, and set the shelf life from the result.

What a change in the pack tells you

A pack that swells is telling you something is producing gas. Microbial growth is one cause, and it is the one that matters most, because a contaminated product can be dangerous as well as spoiled. A chemical reaction between the formula and the pack can also produce gas, and a fermented ingredient can do it on its own. A swollen tube or a domed lid is a reason to quarantine the batch, not to pierce the lid and sell the rest. Open it in a safe place, note the smell and the appearance, and send a sample for a count before any decision is made.

A pack that softens, crazes or stains is telling you the material and the formula are not compatible. Some solvents attack a particular plastic, and some oils migrate into it and leave a greasy mark that cannot be cleaned. A pump that becomes stiff or a closure that no longer seals is a sign of the same problem. Compatibility is tested by filling the actual pack and holding it, not by reading a resin data sheet alone. If a batch has damaged its pack, the product may also have absorbed something from it, and the batch should not be sold.

A split phase inside the pack is telling you the emulsion has failed. A water layer at the top, oil droplets on the surface, or a product that separates when the pack is squeezed are all failures. Shaking the pack mixes the phases for a few minutes and does not restore the structure, so a product that has separated must not be sold as if nothing happened. A separated product is a failed product, even if the phases can be mixed back for an hour. The cause is usually the emulsifier level, the HLF match, the process temperature or a freeze during transport. The record should show which one, because the next batch will repeat it otherwise.

A one-week smell check is not a microbial test, and a pack that looks clean is not proof. The smell check catches strong spoilage and some oxidation, and it is cheap, so it is worth doing. It cannot tell you the count, and it cannot tell you whether the preservative will hold for the life of the product. Only a count and a challenge test on the finished formula in the final pack can do that. The pack tells you where to look; the lab tells you what is there. Keep both in the record, and never let a pleasant smell close a file that has no test behind it.

- 1. Check every stability sample for swelling, doming, softening, crazing and staining.
- 2. Quarantine any batch whose pack has swollen, and order a microbial count.
- 3. Note the smell and appearance when the pack is opened, and record them with the date.
- 4. Check the pack and the closure for damage before blaming the formula.
- 5. Treat a split phase as a fail, and do not sell the batch after shaking it.
- 6. Use a one-week smell check as an early warning, and never as a microbial result.
- 7. Keep a retained sample in the same pack, so a complaint can be compared with the original.
- 8. Record the pack type, supplier lot, fill date and test report with the batch.

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> **Bench example: a tube that smelled of solvent**
>
> A 100 ml tube of hand cream is returned with a soft wall and a smell of solvent. The batch record shows the formula unchanged for six months, but the tube supplier has changed the resin. A trial fill of the same batch in the old tube and the new tube is held for two weeks. The old tube is unchanged. The new tube is soft at the shoulder and the cream inside smells of plastic. The new tube is rejected, the batch is quarantined, and the supplier is asked for the resin change. The salon does not sell the batch, because the product may have absorbed material from the pack. The lesson is that a pack change is a formula change, and a smell that was not there at fill is a result worth acting on. The batch was destroyed, the tube was removed from the range, and the record shows why. The next order of tubes carries the old resin specification. The returned tube is kept as evidence, and the supplier is told why the order was rejected.

CAUTION

A swollen, soft or stained pack is a fail, not a packaging inconvenience. Quarantine the batch and test before any sale.

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Glossary

Percent w/w

Grams of an ingredient per 100 grams of finished product.

q.s.

Add enough to reach the stated value, usually the stated pH or the 100 percent total.

Phase A

The water-soluble group of a formula, heated with phase B to about 70 to 75 C.

Phase B

The oil-soluble group, including oils, waxes, fatty alcohols and the emulsifier pair.

Phase C

Heat-sensitive additions, made under about 40 C with slow stirring.

Phase D

The adjustment group: acid, alkali, salt or a small premix added in drops.

Water to 100

The water line is the remainder after every other line is weighed.

Active matter

The strength of the working material inside a raw material, such as 70 percent in a surfactant paste.

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INCI

International Nomenclature of Cosmetic Ingredients, the naming system used on labels.

O/W emulsion

Oil droplets suspended in a continuous water phase; the usual lotion or cream.

W/O emulsion

Water droplets suspended in a continuous oil phase; heavier, water-resistant, harder to preserve.

HLB

A number describing how water-loving or oil-loving an emulsifier is; the blend must match the oil blend.

Fatty alcohol

Cetearyl, cetyl or stearyl alcohol; gives body and supports an emulsion but does not form one alone.

Anionic surfactant

A negatively charged cleanser, such as a sulfate or an isethionate.

Amphoteric surfactant

A cleanser that behaves as positive or negative depending on pH; a betaine is the common example.

Cationic

A positively charged material, used for conditioning and antistatic effect on hair.

Chelator

A material such as disodium EDTA that binds metal ions and supports preservation and antioxidant action.

Humectant

A material such as glycerin that holds water at the skin surface.

Occlusive

A material that slows water loss from the skin, such as dimethicone or a wax.

Emollient

An oil or ester that softens and smooths the skin surface.

Preservative

A material that limits microbial growth in a water-containing product.

Antioxidant

A material such as tocopherol that slows oxidation of oils; it is not a preservative.

Rancidity

Oxidation of an oil, with a stale smell and often a colour change.

Challenge test

A laboratory test that inoculates the product with known microbes and measures the kill or hold over time.

Microbial count

A laboratory measure of the living microbes in a sample at the time it was taken.

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Stability screen

Samples held warm, cold, freeze-thawed and at room temperature, read on a schedule.

pH

A logarithmic scale of acidity and alkalinity; skin and most leave-on products sit on the acid side.

Buffer

A system that resists a change in pH when a small amount of acid or alkali is added.

Viscosity

A measure of thickness, read at a stated temperature, spindle and speed.

Yield

The weight of product actually filled, compared with the theoretical batch weight.

Period after opening

The time a product is expected to remain acceptable once the client opens it.

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