



ULTIMATE GUIDE TO EXTENDING OIL LIFE

Everything you need to know to lower the cost of frying with oil



CONTENTS

Introduction	1
---------------------------	----------

OIL

More than a cooking medium	2
What frying oil is right for you?	4

OIL MANAGEMENT

Why oil breaks down	7
Why filtering is so important	11
How to think about the Cost of Frying with Oil	12

FRYER

Your fryer should help extend oil life, not end it	13
What To Know About Different Fryers and Oil Care	16
What it means to reduce the number of discards	19

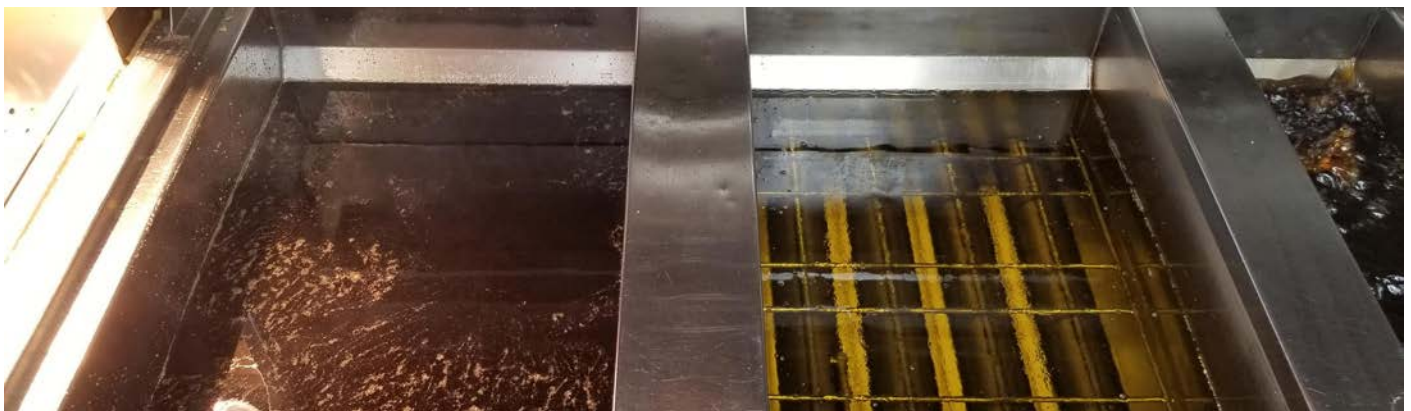
Conclusion	20
-------------------------	-----------

INTRODUCTION

At Henny Penny, we tell anyone willing to listen that frying oil is the first or second highest ongoing expense in a commercial deep-frying program. With the cost of most common frying oils doubling and even tripling over the past year, it's not enough to simply shift to a less expensive oil and hope your guests won't notice the difference. There is more competition than ever to serve the healthier, higher quality fried foods consumers love. It is time for operators to take control and start lowering the cost of frying through *oil management*.

This means looking beyond the price of frying oil and determining what you can do to use less of it and make it last longer. It is a long-term strategy that combines best practices in oil management with fryers designed to protect frying oil rather than destroy it.

To be sure, some oils are better than others for deep frying. Choosing the right oil for your program involves balancing price against things like flavor profile, stability and fat content. Just keep in mind that extending the useful life of your oil and reducing the number of discards in a year can save you **thousands per store** in labor, productivity and frying oil, no matter what oil you use or how much you pay for it. And with better fryers, you can double or even triple these savings.



MORE THAN A COOKING MEDIUM

Deep frying is like baking, only with oil. It's faster than baking because oil is much more efficient than air at transferring heat directly to food. But oil is more than just a cooking medium. It's part of the food. Anyone who makes – or eats – French fries can appreciate this: a properly cooked French fry will have exchanged roughly 30% of its moisture for frying oil!

Edible oils come from various grains, nuts, vegetables, trees and animals. Each one has a flavor profile and percentage of various fats that suggest its relative nutritional value. Each type of oil also has a unique chemical composition that determines certain important properties, such as stability and smoke point.

The five most popular deep-frying oils according to a survey of the Henny Penny global distribution network:



#1 Canola Oil

is made from the rapeseed plant, which produces a light oil with a neutral flavor. Canola oil is usually highly refined to make it more stable at high temperatures, giving it a smoke point as high as 400 F.

Fatty Acid Composition:

Saturated fats	< 7%
Monounsaturated fats: (oleic acids)	50-65%
Polyunsaturated fats (linoleic acids)	28-43%



#2 Blended Oils

typically contain canola oil and some combination of other vegetable oils. They are quite popular since they allow operators to choose a blend with certain characteristics of its constituent single-type oils. Since there are many common blends in use, flavor profiles, smoke-points and fatty acid composition will vary.



#3 Soybean Oil

is one of the most popular deep-frying oils. It has a neutral flavor, with a very high smoke point of up to 495 F and good stability, although it contains about twice the percentage of saturated fats. Soybean oil is readily available from most suppliers in both regular and non-GMO formulations.

Fatty Acid Composition:

Saturated fats	15%
Monounsaturated fats: (oleic acids)	18-23%
Polyunsaturated fats (linoleic acids)	62-67%



#4 Corn Oil

(refined) is a light to medium yellow oil with a mild, slightly butter flavor and a very high smoke point of up to 450 F.

Fatty Acid Composition:

Saturated fats	13%
Monounsaturated fats: (oleic acids)	24%
Polyunsaturated fats (linoleic acids)	59-62%



#5 Peanut Oil

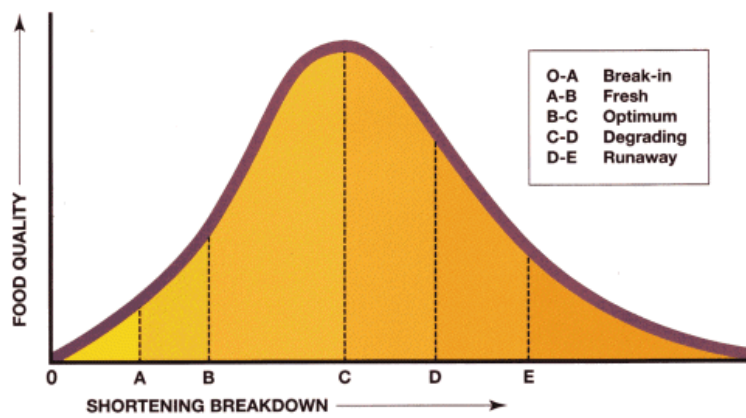
is a slightly deeper yellow color with a neutral to sweet flavor that is often favored for fried cakes and breads. It is exceptionally stable and has a very high smoke point of up to 450 F. Peanut oil does not contain the proteins that trigger allergic reactions, although it is highest in saturated fats of the oils surveyed.

Fatty Acid Composition:

Saturated fats	19%
Monounsaturated fats: (oleic acids)	45-53%
Polyunsaturated fats (linoleic acids)	27-32%

A note on pricing

The global network was also asked to provide current pricing for these oils. Actual prices change frequently and vary considerably by geographic area and availability. Over the first half of 2021, the survey showed less than a 5 percent difference in the average reported price per pound for soybean, canola, corn and blended oils. Peanut oil was roughly 30 percent higher.



Solid or semi-solid shortening

Both single-type oils and blends have long been available in solid and semi-solid forms, commonly referred to as shortening. This involves processing methods that substitute a portion of unsaturated fats found in vegetable oils with saturated fats from lard, or chemically through the addition of hydrogen. Solid and semi-solid forms have much higher melting points, which gives them a longer room-temperature shelf life. What you gain in stability and bulk-savings you trade for a less healthy cooked product.

WHAT FRYING OIL IS RIGHT FOR YOU?

Along with price, operators should consider these attributes when deciding on a frying oil.

Flavor Profile

Certain oils, like olive and coconut oil, have fairly distinct flavor profiles that make them less suitable for deep frying, except for specific menu items. Others, like corn oil and peanut oil have a milder and more universal flavor that goes well with chicken protein and starches, and just about anything.

Nutritional Value

Some oils are clearly better for your health than others. This mainly has to do with the link between types of fatty acids and good or bad cholesterol levels. Without descending into the chemistry of organic compounds, it is enough to remember that oils with high levels of saturated fats are considered less healthy than those with mainly monounsaturated or polyunsaturated fats.

Stability

Stability of an oil is simply a measure of its resistance to the normal chemical reactions that cause oil to break down. Oils high in saturated fats are inherently stable because the molecular bonds of these fatty acids are already maxed out. Oils with mostly unsaturated fatty acids bond more easily with oxygen molecules (oxidation) and either break up as free fatty acids (FFAs) or reform into larger non-reactive contaminants (polymerization) that can cluster into particles.

Oil stability and nutritional value

All oils become less healthy as they break down. Darker color and rancid or acidic taste are indications of chemical changes and impurities in oil. Food fried in oil high in saturated fats but in good condition will always be healthier than food fried in oil low in saturated fats that has accumulated toxic compounds from oxidation, hydrolysis and polymerization.








Why a high smoke point matters

If you constantly cook with a stable oil near its smoke point, it will break down sooner. Oils with high smoke points may start out less stable but last longer because you are cooking at temperatures well below the smoke point. Smoke points for refined versions of popular oils will be higher. For deep frying, be sure the manufacturer's stated smoke point is at least 20 to 30 degrees F higher than your average cook temperature. Remember, the smoke point will occur at lower temperatures as oil breaks down.

Smoke Point

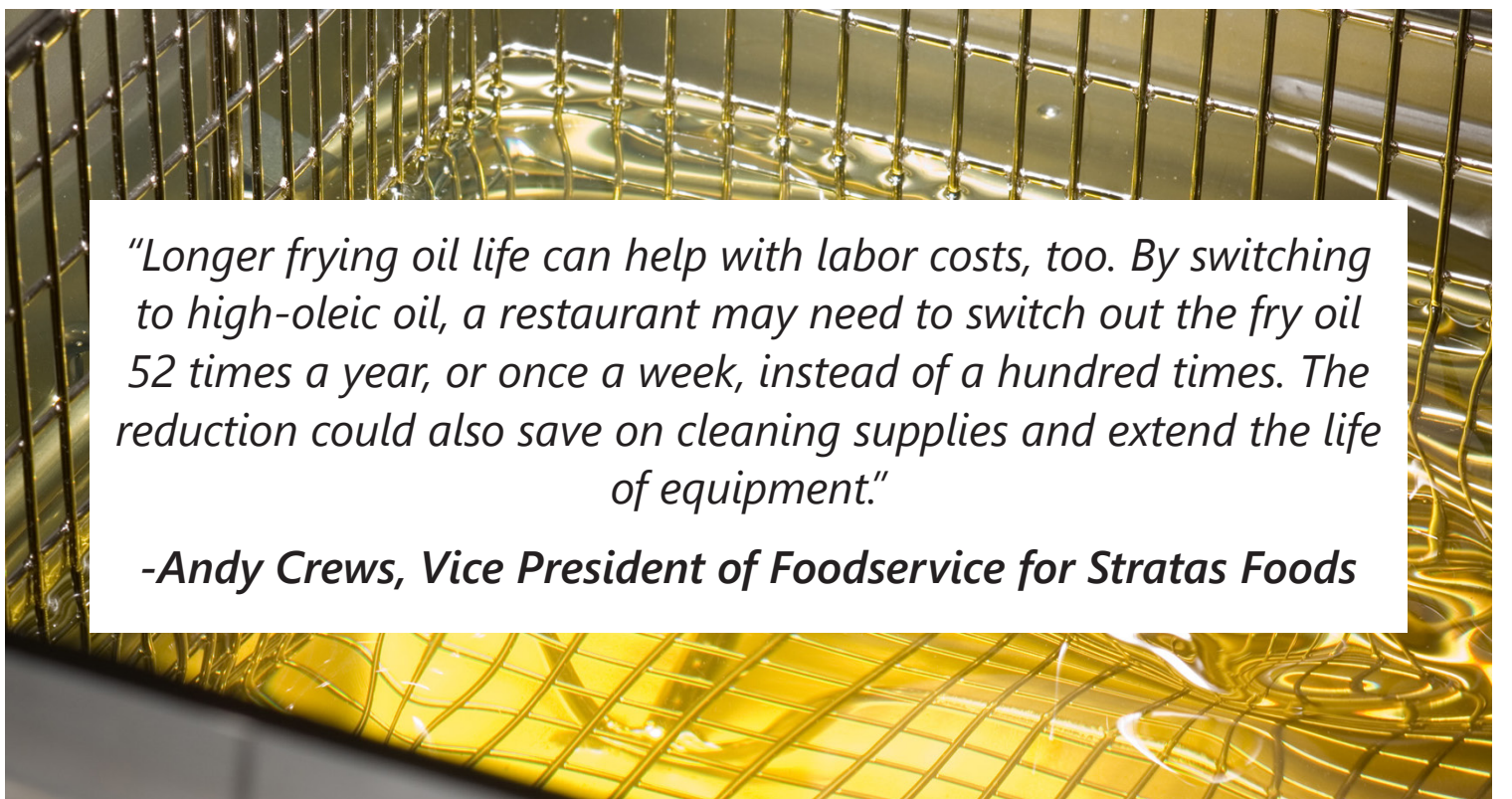
Things change, however, when oil is heated. Heat accelerates oxidation in all oils. The higher the temperature before significant breakdown (smoke point) the more suitable an oil is for deep frying. To complicate matters, many oils high in saturated fats have fairly low smoke points, while others that are high in polyunsaturated fats, like corn and soybean oil, have very high smoke points.

TOP 5 FRYING OILS AND THEIR PROPERTIES

Oils	Smoke Point	Flavor Profile	Stability	Dietary Fat Composition %		
 Canola Oil	<u>400 F (204 C)</u>	Neutral *	● ● ●	7	50-60	28-43
 Blended Oil <i>Properties and fat composition will vary</i>					
 Soybean Oil	<u>495 F (257 C)</u>	Neutral	● ● ●	15	62-67	18-23
 Corn Oil	<u>450 F (232 C)</u>	Milk, slightly buttery	● ● ●	13	59-62	24
 Peanut Oil	<u>450 F (232 C)</u>	Neutral to sweet	● ● ● ● ●	19	27-32	45-53

* SLIGHT FISHY FLAVOR WHEN COOKED AT HIGH TEMPS

Saturated fat
 Monounsaturated fats (oleic acids)
 Polyunsaturated fats (linoleic acids)



“Longer frying oil life can help with labor costs, too. By switching to high-oleic oil, a restaurant may need to switch out the fry oil 52 times a year, or once a week, instead of a hundred times. The reduction could also save on cleaning supplies and extend the life of equipment.”

-Andy Crews, Vice President of Foodservice for Stratas Foods

WHY OIL BREAKS DOWN

No matter what you do, frying oil has a limited lifespan. Three common chemical reactions contribute to the breakdown of cooking oil.

Oxidation

Oxidation occurs when oxygen molecules react with long fatty acid chains in the oil and break them up. Heat catalyzes the reaction and accelerates oxidation. Trace metals, foreign matter, even UV light can cause oxidation in oil.

Hydrolysis

This reaction is caused mostly by hydrogen molecules in water reacting with frying oil, giving cooked product a tainted or acidic flavor. Excess moisture, acids, high temperatures, foreign matter, the chemistry of certain detergents and emulsifiers, and the "free" fatty acids (FFAs) caused by oxidation all promote hydrolysis.

Polymerization

As frying oil deteriorates, the non-volatile products of oxidation and hydrolysis begin "polymerizing" or bonding together at high oil temperatures to form clusters that accumulate on the oil's surface. These particles are large enough to cause foaming, which increases the rate of further breakdown.



Let's look more closely at the normal things in a frying operation that cause oil to oxidize, hydrolyze or polymerize and how to counter them.



Heat

Obviously, you can't fry without heat. But extreme heat violently accelerates oxidation in oil. That's why knowing your oil's smoke point is useful. As long as you are frying at temperatures well below the smoke point, even high temperatures are not necessarily extreme. Pressure fryers let you cook at lower temperatures in less time, which is the main reason they are easier on oil than open fryers.

How you arrive at cooking temperature is just as important. Oil temperature should be raised slowly to minimize the temperature gradient between hot and cold volumes of oil in the vat as it heats up. And when idle, oil temperature should be allowed to cool to ambient conditions or lowered by at least 20 F in between busy periods.



Air

Exposure to air is unavoidable. Like other organic compounds, long exposure to open air essentially causes oil to spoil. Covering vats at night or when not in use helps protect oil from a constant flow of fresh air at the surface. Pressure fryers have a built-in advantage here, as well, with a lid that is closed while cooking and when idle.

Pumping oil in and out of vats during filtering also introduces oxygen into the oil, although the benefits of filtering far outweigh the issue of a little extra air. Henny Penny fryers are designed for fast filtering that minimizes pump time.



Moisture

As you might guess, moisture is the main culprit of hydrolysis. There is water in everything we fry, and as moisture is "baked" out of the food, it escapes directly into the hot oil and causes the reactions that lead to breakdown. Avoid excess moisture simply by loading fry baskets away from the vat and by making sure the vat and baskets are completely dry after cleanout before coming in contact with oil.



Carbon, salt, and soap

Carbon from breaching fall off, salts from seasoning or trace metals, and chemical residue from detergents all contribute to oxidation, hydrolysis and the formation of polymers and other dissolved impurities together measured as Total Polar Materials. To reduce these contaminants:

- Never season food over an open vat
- Follow proper breaching techniques to minimize fall off
- Skim vats frequently
- Brush out crumbs as oil drains for filtering
- Use filter media and absorbents that remove dissolved impurities



Keep cooking if you can

Preserving oil life is an exercise in balancing contradictory conditions. When frying oil in a vat sits around at room temperature it spoils. When you heat it up too fast it breaks down quicker. Tests have shown that brief periods of cooking followed by long idle periods are hard on oil. High volume operations where fryers are cooking most of the day and filtered frequently actually get more life out of their oil. Most fryers worth the money will have an idle mode that lowers oil temperature gradually when not in use and a melt mode that heats room temperature oil gradually to avoid “shocking” it.

Keep vats clean and dry

If you do not remove carbon, polymers, trace metals and chemical cleaner residue from the surface of vats during cleaning you doom your next vat of oil to a shorter life. Heavy scrubbing and caustic chemical cleaners are not the answer. We recommend [Prime Cleaner](#), a powerful non-caustic degreasing formula designed specifically for deep fryer vat cleanout. It's easy to use and requires no heavy scrubbing or neutralizing rinse.

Pro tip: Set fry baskets in vats during cleaning. Make sure everything is bone dry before adding fresh oil (see “Moisture” above.)

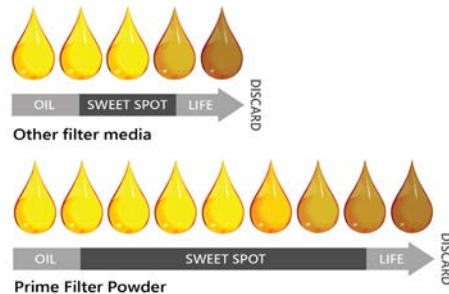


Polymerization makes it more difficult to clean frying equipment, but high-oleic oils cut down on polymerization. Too much polymerization also requires more heat to keep the correct temperature in the frying process.

-Dave Booher, Director of Phoenix-based Jensen Foods

WHY FILTERING IS SO IMPORTANT

In the fight to prolong oil life, much of the damage done by these “enemies of oil” can be reversed by reconditioning your oil, a.k.a. filtering. In fact, frequent filtering is the single most important thing you can do to extend the life of your frying oil.



Most commercial fryers these days have built-in filtering systems that drain oil through a fibrous pad or paper envelope and pump it back into the vat. Depending on the type of filter media or absorbents you use, this simple process removes most of the undissolved particles that help oxidize oil as well as the dissolved impurities and FFAs that are the product and the cause of further breakdown.

As we will see in the next section, filtration frequency and media will vary depending on the size and type of fryer vat. But in all cases, the more you filter the longer you can extend the “sweet spot” of frying oil.

Extending the sweet spot

A fresh vat of frying oil has a short break-in period, where it takes several cook cycles and a filter or two before it reaches optimum condition. Near its discard point, oil color – arguably the best means of judging the condition – begins to darken and the oil is more readily absorbed by food, affecting its flavor. In between is the “sweet spot,” the condition that is perfect for frying consistently great-tasting food. Adding days to the sweet spot is the whole object of the game.

- Filtering at every opportunity is the best way to add days, or even weeks, to the sweet spot.
- Keep the vat filled to the proper level. Frequent add-backs of fresh oil maximizes the ratio of good oil to degraded oil over time and helps moderate temperature swings that harm oil.
- Using filter media and filter powder that removes dissolved impurities as well as particles can double the life of your oil’s sweet spot.

How often should you filter? The easy answer is at every opportunity. But at some point, you might be filtering when you should be frying. For starters, it depends a great deal on the type of vat. Side by side, reduced oil capacity vats need to filter more frequently than standard vats, and are programmed for express filters after a given number of cook cycles – more on that in the next section. Store volume, type of menu item, portion and basket size are all factors that determine filter frequency, as are cook time and temperature and aging. As frying oil degrades, it absorbs contaminants more easily and should be filtered more often toward the end of its service.

In general, you can relate filter frequency to the amount of damage your product does to the oil as it cooks. Freshly breaded bone-in chicken that cooks for 11 minutes may require filtering after 4-6 drops. With freezer-to-fryer French fries in a half basket you may get three times as many drops before filtering. For guidance on determining how often you should filter in your own kitchen, click here for our [Filter Frequency Worksheet](#).

HOW TO THINK ABOUT THE COST OF FRYING WITH OIL

DIRECT COST

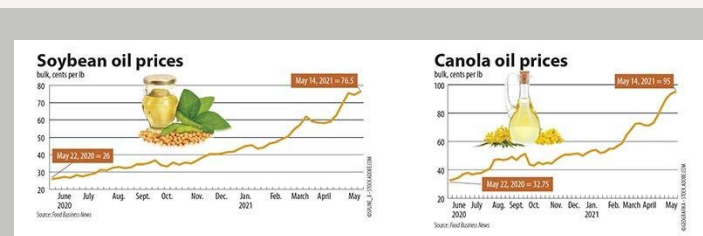
Oil

Frying oil prices are variable and currently on the rise due to post-pandemic increase in demand and competitive pressure of bio-fuel mandates. Make sure the manufacturer's stated smoke point is suitable for high volume deep frying. Balancing nutritional value and stability may result in a higher priced oil but pay off in extended oil life and higher quality deep fried product.

LABOR/PRODUCTIVITY

Filtering and replenish

Filtering, polishing and replenishing oil throughout the day takes labor and time away from frying. Yet adding days and weeks to oil life pays that back with interest. If you use standard fryers, compare the productivity cost of additional filter and polish throughout the day against savings from adding days of oil life. Consider a reduced oil capacity fryer with 4-minute express filters as needed and automatic replenishment that extends oil life 3X or more.



Disposal/fresh fill/oil break in

Obviously, the fewer disposal points the better. Less oil consumed, less unproductive labor. Fewer deliveries. With an extended sweet spot and fewer disposals, you also have fewer break-in cook cycles.

Filter media, absorbents

Depending on volume, you may be filtering vats multiple times each day. Make filtering more effective with media and/or powder absorbent that remove dissolved impurities as well as particles. Oil sweet spot lasts longer, vats are easier to clean.

Vat Clean-out

Longer oil life means fewer vat cleanouts. The right oil and filter media can reduce cleanout time and the need for caustic chemical cleaners. Compare potentially higher price of oil and filter media with lower maintenance labor costs.

YOUR FRYER SHOULD HELP EXTEND OIL LIFE, NOT END IT

We've talked about the rising cost of oil itself and what you can do to manage it:

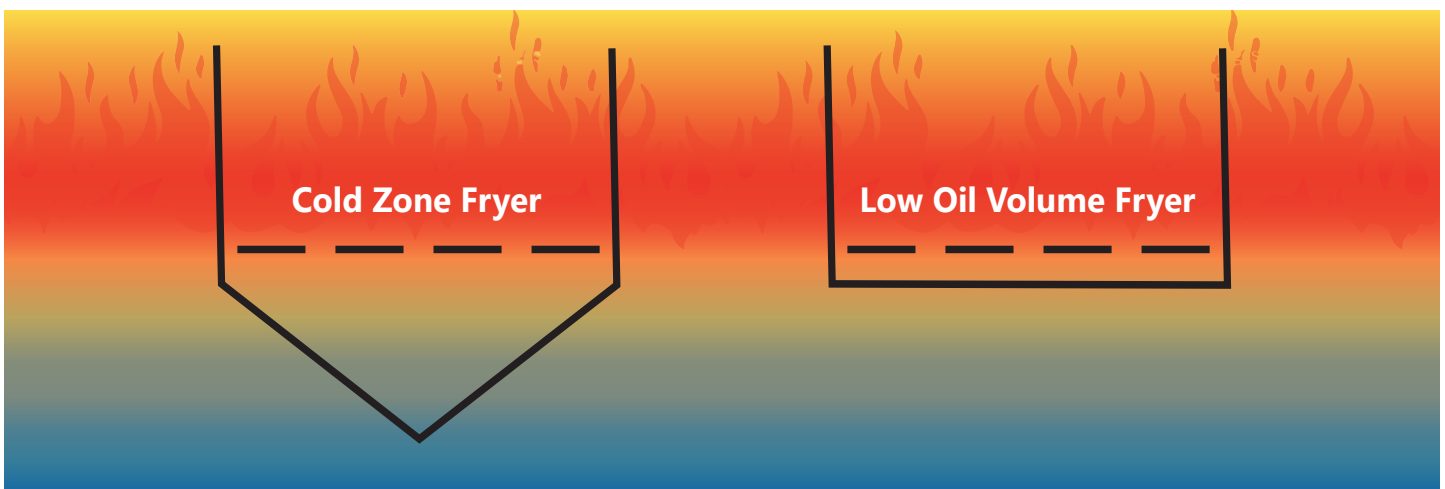


- Switch to an oil blend that is more price resistant
- Implement better frying and oil management habits
- Filter more often and use media or absorbent that remove dissolved contaminants

All of this can be done with the fryers you already have. But if you haven't seen a new fryer in action lately, you will be amazed at how much more this newer technology can extend oil life and leverage your oil management savings. In fact, the right fryer for your application can add days – even weeks – to the life of your oil.

Long ago, Henny Penny understood the importance of building fryers that took better care of oil. This focus on preserving oil led to improvements in energy efficiency, productivity and control features that not only lower the cost of frying but result in a higher quality, more consistent deep-fried product.

But we didn't stop there. Henny Penny pioneered the reduced oil capacity fryer. This type of fryer cooks the same amount of food in 40% less oil, so you're using a lot less oil right from the start. But there are important differences between low oil volume fryers and standard vat fryers, both in how they work and what they cook best.

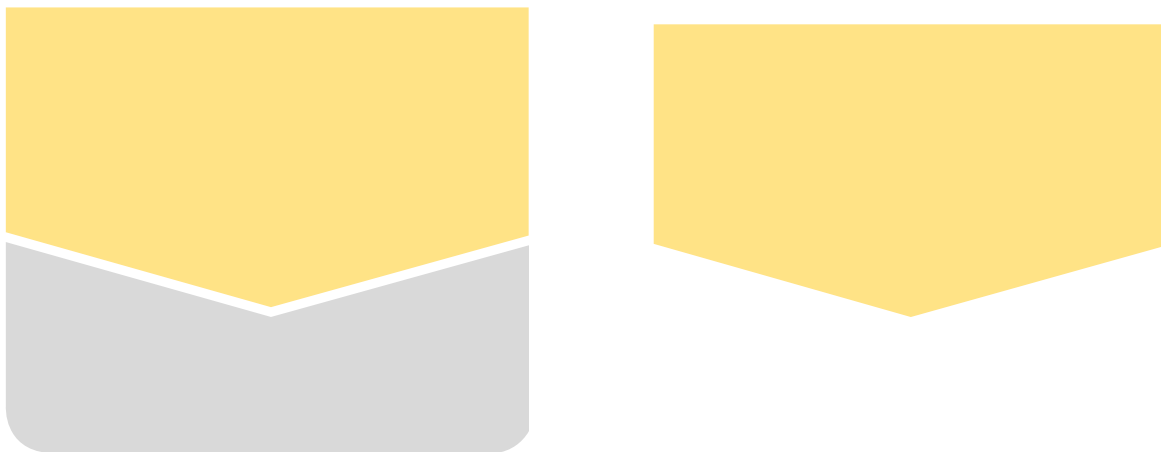


The standard (50–65 lb) vat open fryer is designed to balance the right amount of oil to product so that temperature can recover quickly without wasting energy. Dropping a load of cold or frozen product abruptly lowers the temperature of the surrounding oil. The more hot oil there is in the vat, the less impact this has on the remainder and the quicker it recovers to cooking temperature. Moderating this temperature gradient – whether rising to temperature or cooling from product – is a form of protection against extreme changes in temperature that damages oil.

An even more important oil-saving feature of the standard vat is the “cold” zone, the bottom volume of the vat below the basket and heating elements where the temperature of the oil is lower. This prevents crumbs and breading falloff from excess carbonizing and scorching the vat in between filters, or causing oil to foam in the cooking zone.

The Reduced Oil Capacity vat fryer represents a newer approach to reducing oil consumption and discard. These vats cook the same amount of product in significantly less oil. The vat is designed without a cold zone, which is where most of the savings by volume come from. In order to protect this smaller volume of oil, the oil must be filtered and replenished after a certain number of loads. The technology of fryers like the Henny Penny Evolution Elite and Velocity Series makes this fast and easy. For instance, the oil from one vat on a multi-well Evolution Elite fryer can be filtered in 4 minutes while you continue to cook in other vats. The Velocity Series pressure and open fryers filter automatically after every load in about the time it takes to prepare another load. Both fryers replenish oil automatically from an onboard supply.

The Evolution Elite cooks in 30 lb oil, or around 40% less than a standard vat. The high (product) volume Velocity Series pressure and open fryers cook in 75 lb oil, around 25% less than conventional high-volume fryers



Why does oil last longer in a pressure fryer?

Pressure fryers are the original oil-saving fryer. Henny Penny got its start by introducing the world's first commercial pressure fryer back in 1957. Pressure fryers use less oil and cook faster than open fryers because the cooking chamber is sealed. Under about 12 psi pressure, food cooks faster and absorbs less oil. Vats have a cold zone to collect crumbs and fall-off but require less oil volume to recover because cook temperatures are lower.

Pressure builds, raising the water's boiling point

High smoke point frying oil

Uninsulated Cold zone so food particles dont burn



Advantages of Using a Pressure Fryer

1. The collagen in tough pieces of meat like the leg and thighs breaks down faster, yielding a tender product with less cook time.
2. Less moisture from the product is evaporated, leading to a juicier piece of meat.
3. Less moisture being released into the oil means less hydrolysis, so the oil will last much longer.

WHAT TO KNOW ABOUT DIFFERENT FRYERS AND OIL CARE

Standard vat fryers: Henny Penny 320 Series

Best for: Fresh breaded proteins, veggies, starches, extra crispy chicken

Oil capacity: 65 lb

Skim: Before each load as needed

Replenish oil: As needed when it falls more than 1 inch below the cook level fill line

Filter and polish: 2 or more times per day depending on volume and type of product

Media: Filter envelope over screen

Absorbent: Henny Penny Prime Filter powder during polish – removes FFAs, polymers

Average oil life with good practices:

7 – 10 days, depending on volume and product



Reduced Oil Capacity Open Fryers: Evolution Elite

Best for: Freezer-to-fryer starches, proteins, fish or fresh items with light or no breading

Oil capacity: 30 lb

Skim: Before each load as needed

Replenish: Automatic

Filter: 4-minute express filter on prompt – cook cycle interval varies with product

Maintenance filter and polish once daily

Media: Henny Penny Prime Filter pad – removes FFAs, polymers

Absorbent: Henny Penny Prime Filter powder during polish – removes FFAs, polymers (not required if Henny Penny Prime Filter pad is used as media)

Average oil life with good practices: 14 – 21 days depending on volume and product



Pressure Fryers: 4-head 500/600 Series

Best for: Fresh breaded bone-in chicken, pork chops, fresh breaded starches & veggies

Oil capacity: 48 lb

Skim: Before each load as needed

Replenish: As needed when it falls more than 1 inch below the cook level fill line

Filter: Once daily

Media: Filter envelope over screen

Absorbent: Henny Penny Prime Filter powder during polish – removes FFAs, polymers

Average oil life with good practices:

10 – 14 days depending on volume and product



Reduced Oil Capacity Pressure Fryers: 8-head Velocity Series

Best for: High volume fresh breaded bone-in chicken, pork chops, fresh breaded starches & veggies

Oil capacity: 75 lb

Skim: Before each load as needed

Replenish: Automatic

Filter: Automatic express filter after every load Maintenance filter and polish once daily

Media: Filter envelope over screen

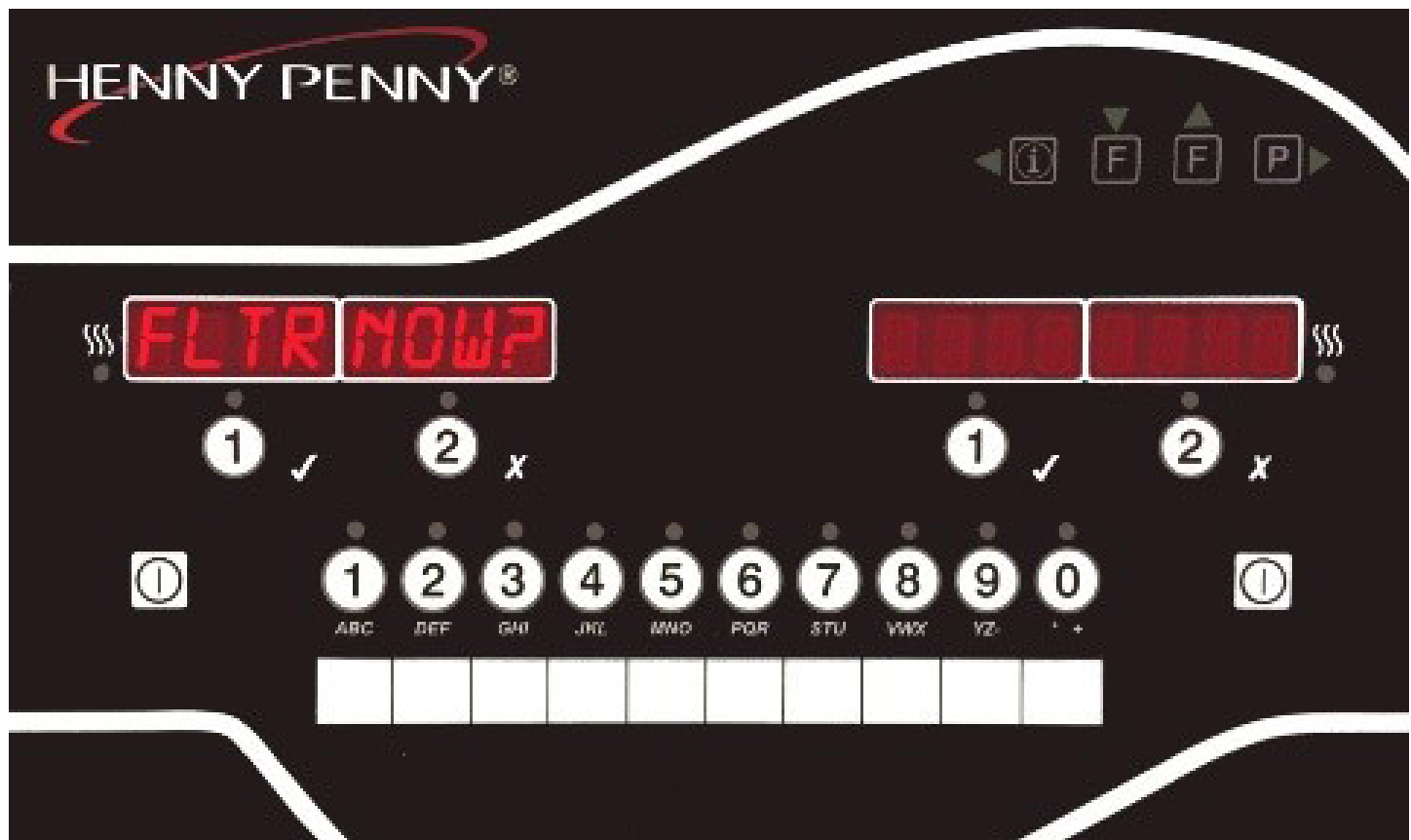
Absorbent: Henny Penny Prime Filter powder during polish – removes FFAs, polymers

Average oil life with good practices: 60 days depending on volume and product



Oil management controls available on all Henny Penny fryers

- Built-in filtration system
- Melt mode: raises oil temperature gradually
- Idle mode: automatically lowers oil temperature between periods of operation
- Proportion Control: prevents over or under heating of oil
- Filter tracking, prompt and lockout: uses cook cycle history to customize and control filter frequency



WHAT IT MEANS TO REDUCE THE NUMBER OF DISCARDS

There are a lot of ways to extend the life of your frying oil, and a lot of cascading benefits when you do – most of them financial. For example, if you are able to double the life of your oil, you also cut the number of discards in half. Discarding oil is a maintenance task that does not add to productivity but still costs you labor. Going from a 100 discards per year to 50 would save an operator thousands per vat per year.

The same is true for vat cleanouts. Frying oils like canola oil that are resistant to polymerization make cleaning fry vats much easier. This is also a good reason to use filter media or absorbent like [Henny Penny Prime Filter Powder and Prime Filter Pads](#) that are designed to extract soluble impurities including polymers. (Activated Carbon filtration pads do not.)

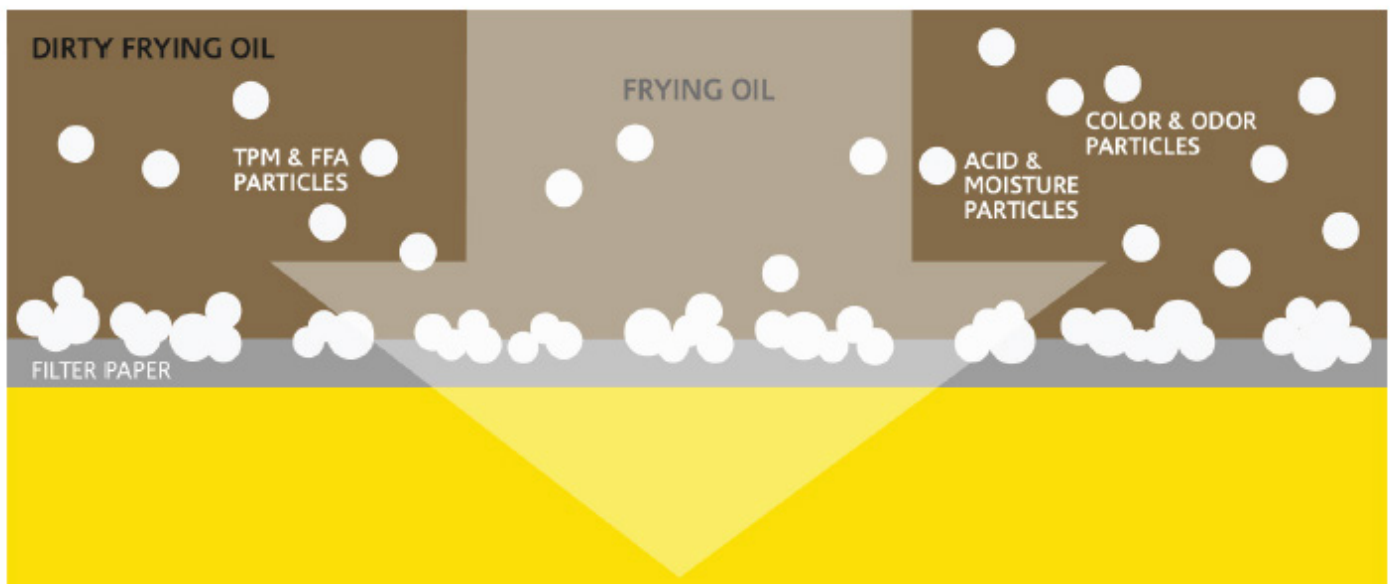
Fewer discards lessens the environmental impact of frying for every store. First, you're generating less spent oil to recycle or dispose of. But you are also reducing the amount of new oil being used. That means lower environmental costs for manufacture, delivery and packaging.



CONCLUSION

Better oils, better fryers and better frying habits all lead to serving a more consistent, high-quality fried product for your guests. But as an operator, you have to make money doing it. And that can be a challenge, even when oil prices aren't going through the roof. Take it from the frying experts at Henny Penny: the care and filtering of your oil is the number one way to manage the cost of your frying program. Every additional day you add to the life of your oil at its peak condition is money in the bank.

There are a lot of factors that make extending oil life a moving target. But with a little training, kitchen crews will quickly learn how to make oil last longer. After all, someone has to dispose of it. The less often the better! Henny Penny makes it easy for operators to program fryers with filter prompts at the ideal intervals. Using [Henny Penny Prime Filter pads and filter powder](#) has been shown to double the number of days your oil stays in the "sweet spot." In the end, your actual oil savings will depend on the number of vats, menu items, volume and throughput, and type of fryers used in your stores. It's not going to be a small number.




If you're interested in the next step, why not schedule a [no-obligation Oil Savings Audit](#)? We'll hook you up with a Henny Penny distributor in your market who will review your frying program and discuss types of oil, suppliers and procedures to create the best version of your menu while making your oil last longer. They will even help you test your products in our industry-leading fryers in a test kitchen or alongside the current fryers in your kitchen under actual conditions.

We have helped the biggest names in the restaurant business net millions in frying oil savings by finding the right mix of oil, product, fryer and best practices. We can do the same for you.

CLICK HERE TO REQUEST AN OIL SAVINGS AUDIT

Oil Savings Audit

Ready to take oil management to the next level? Fill out the form to the right and we'll connect you with your local Henny Penny distributor who will review your frying program and discuss types of oil, suppliers and procedures to create the best version of your menu while making your oil last longer (and saving you \$\$\$).



First Name *

Last Name *

Email *

Number of Locations *

- Select a Value -

Zip Code (Headquarters if more than one location) *

State *

State/Province

Country *

- Select a Country -

REQUEST AUDIT NOW

protected by reCAPTCHA
Privacy - Terms