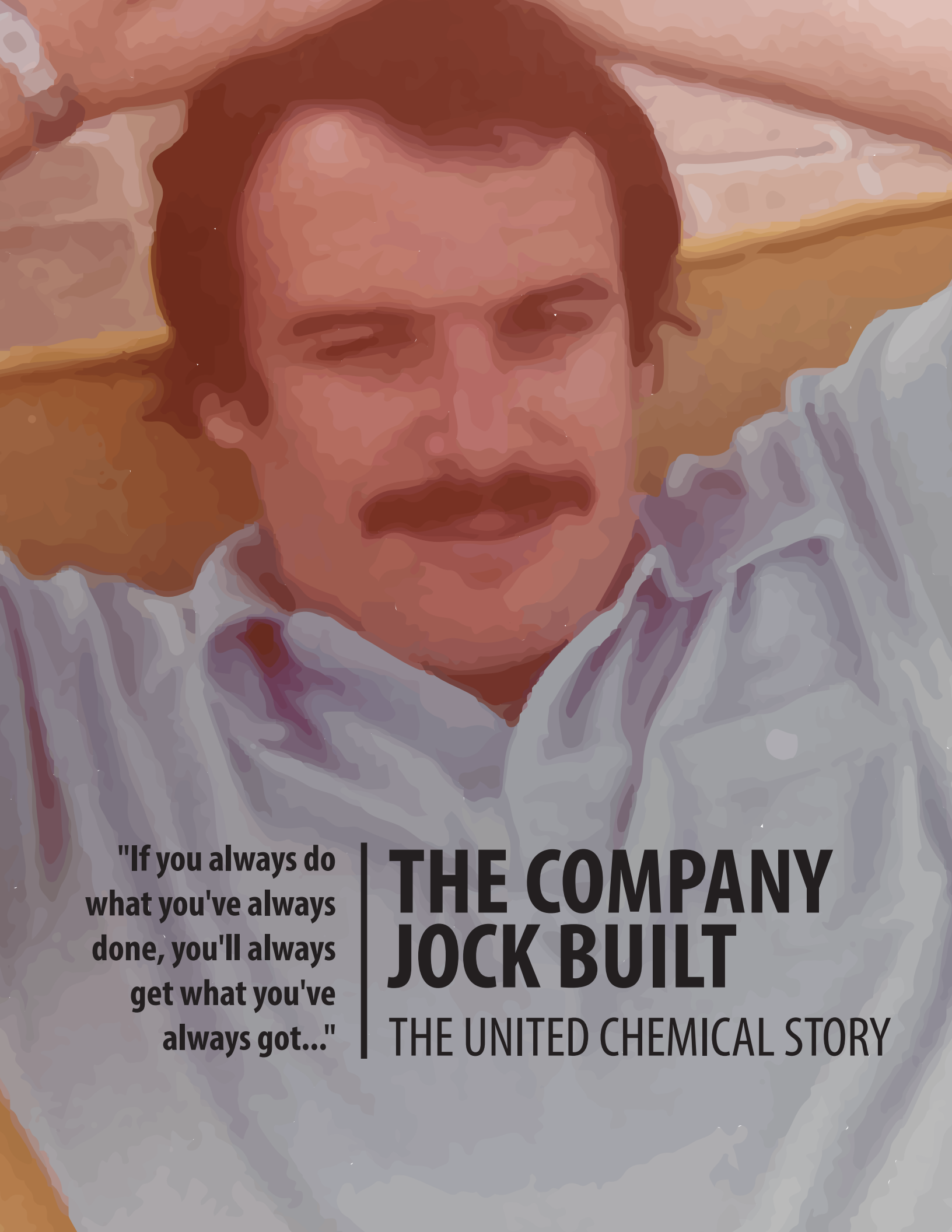
UNITED CHEMICAL

DIVE IN
A BETTER POOL

HONESTY
INTEGRITY
INNOVATION
EDUCATION



"If you always do what you've always done, you'll always get what you've always got..."

THE COMPANY JOCK BUILT

THE UNITED CHEMICAL STORY

The story of United Chemical is the story of its founder: Jock Hamilton. He was a legend and pillar of the pool industry.

Jock started off as most do in the pool industry - as a service technician. He purchased "Allied Pools" - a route owned by his brother Tony Hamilton, and began servicing high end clients in the Brentwood area of Southern California.

He would eventually make a name for himself challenging industry dogma of balancing. Jock noticed that many pools he serviced had problems despite being properly balanced according to the industry's Langelier Saturation Index. He decided to take it upon himself to learn chemistry to understand what was happening, and often utilizing customer pools as a playground to test hypothesis and build empirical evidence.

Not one to be shy, he was very outspoken in voicing his challenges. Most controversial was his claim that a high pH was more beneficial than a low pH in sanitation (see The pH debate).

Jacki and Jock circa 1981

Jock turned to the manufacturing side of the industry by first attempting to create powdered cyanuric acid for pool use. Although it turned out the process made it too expensive to be cost-effective, the experience helped him prepare for the manufacturing side of business.

BIG BREAK AND THE BIRTH OF A COMPANY

Jock's big break came in 1981: colleague and friend Tony Medina tipped Jock about the possibility that Sodium Bromide could be used as an algaecide. This idea would become United Chemical's first product - Yellow Treat - and the first sodium bromide based algaecide in the industry.

The company was officially born in 1983. Over the years, Jock continued to learn, experiment, and grow - developing his own index for pools (see the Hamilton Index). Also, the product line began to expand with other innovative products - from stain removers to balancers.

As the company grew, Jock utilized it as a platform for educating the industry on balancing. He held classes across the country, touting his revolutionary Index's approach of "high pH, low Alkalinity" - a philosophy that heavily influenced the way we balance today.

LOSING A LEGEND

In 2001, Jock was diagnosed with squamous cell carcinoma. After a year long battle, Jock passed away October 20th 2002 with wife Jacki and son Scott by his side.

"It was quite a shock. Dad seemed invincible. But now he was gone - the man who was the pillar of not just the company but also our lives..." recounts his son Scott. "Basically everything changed overnight."

His wife Jacki was thrust into the helm of the

THE HAMILTON FAMILY (1997)

Pictured Right:
The Hamilton Family circa 1997. From left to right: *Scott, Jacki, Jock*

company. An elementary school teacher by trade, Jacki understood the importance of making people feel appreciated. She made it priority one to keep everyone on board to keep the Company going. And in 2007, United Chemical had a record year with most of the same employees still at the company.

BACK TO BASICS: CORE IDEALOGY

In 2011 Jock's son Scott Hamilton stepped from the background into the role of C.E.O. Spending the last 9 years studying successful organizations, Scott implemented a plan to rekindle the spirit of United Chemical:

"I was very paranoid of us drifting away from the core values that Jock used to build the company. I felt in the last few years we had started to drift from what made us. I made it my obsession to make sure that the company never lost touch with what made it great."

Scott identified a core purpose that drove Jock and United Chemical, and 4 core values that defined how Jock did business: honesty, integrity, education, innovation. He communicated this core ideology through anecdotal stories of conversation and observations he had of his father Jock:

Core Purpose
"I remember I was about 12 and in the car with Dad talking about something science related - we were kind of geeks like that. Dad was incredibly smart, and I marveled at everything he knew. I said 'Dad, you're so smart. Why aren't you working at NASA or President or something? Why not do something that matters?' He thought about it for a second and said 'Well, I think what I do does matter. What I do makes people happy.'

Honesty
"I remember I once lied to my father - it was something relatively small. It took, however, years for me to regain his trust. He often said 'you can do a lot of things to me - but never lie to me.' Jock made it clear and taught me honesty is not just the best, but the only policy."

Integrity
"Dad came home one day and said 'well we just lost $20 million dollars.' I was 12, and I thought we were about to be homeless. He could see the shocked look on my face and chuckled. He had turned down a $20 Million dollar opportunity to sell to a mass-merchandiser. When we asked why he did, he simply replied 'I promised [our customers] I wouldn't.' There was no written contract, but he felt that his word was worth more than anything - even $20 million dollars."

Education
"I went to the office to ask dad a question. He was on the phone and said he would talk to me once he was done helping a customer. I listened to him talk chemistry with this person until nodding off. I woke up hours later to find him talking on the phone. I asked why he didn't wake me when he was done with the previous call. It turns out he was still on the same call. And when he wasn't on the phone, he was reading anything he could get his hands on. He was a non-stop educator - beit someone else or himself.

Innovation
Jock had a phrase he loved to say: 'If you always do what you've always done, you'll always get what you've always got.' He even had me print it out and hang it next to my bed, so it would be the first thing I saw everyday when I woke up. Dad always made it clear that I should try new things, and would tell me to 'take risks, but calculated risk". You look at how he carved his own path in everything he did, and you begin to understand how much innovation was important to him. He loved to tinker, and was never satisfied."

To symbolize this core ideology, Scott created "Jock's Golden Compass", a visual reminder to employees of the company that Jock built.

"While Jock ran the company as an extension of himself, the goal has now been to empower employees to make decisions for themselves. To do that, we've had to help everyone understand how Jock thought and operated."

Jock's philosophy and legacy continues to live on here at United Chemical - from employees to products, and helping further his vision for the industry.

COMPANY TIMELINE

1981

Tony Medina tips Jock about Sodium Bromide use as an algicide. Jock begins experimenting with formulas.

1983

United Chemical is founded, and introduces the first Sodium Bromide based algicide to the industry. The same year, Jock's son Scott is born.

1994

United Chemical algicides become the first Sodium Bromide based algicides registered by EPA. Sodium Bromide is listed as the active ingredient on labels.

2002

After a year long battle with cancer, Jock passes away October 20th.

2011

Scott Hamilton takes over position as CEO of United Chemical, and begins campaign to reinstill Jock's core values of Honest, Integrity, Innovation, and Education

THE DEBATE OVER HIGH PH

pH is an essential balancing factor in regards to sanitation. And the standard for over 50 years has been a pH between 7.2 and 7.6. However, what if this is completely incorrect? What if maintaining this pH range is actually less efficient?

Back when Wilfred Langelier developed his index for scaling in municipal pipes, sanitation wasn't a consideration; the primary focus of his index was to predict scaling behavior based around pH. As the index was adopted for pools, it became clear that pH didn't just impact scaling, but also sanitation. Thus enters the phenomenon of "active" and "inactive" chlorine.

"ACTIVE" AND "INACTIVE" CHLORINE

Active and Inactive chlorine is a bit of a misnomer: both forms of chlorine are active, but behave differently. Active chlorine is hypochlorous acid - the agent more effective at killing algae. Inactive chlorine, or hypochlorites, also sanitizes - but at a slower rate. Hypochlorites, however, are better at oxidizing - or breaking apart - organic matter.

pH controls the ratio of these two forms of chlorine: as pH decreases, hypochlorous acid increases and hypochlorites decrease. The inverse is true as pH raises, and the point where both are equal, is around a ph of 7.5.

The recommendation of running a pH of 7.2 to 7.6 is aimed at the balance between all factors: not too low a pH to cause corrosivity to equipment, not too high to cause scaling, and to maximize the amount of hypochlorous acid.

However, this makes several assumptions that begin to fail when we consider the pool environment, and a deeper understanding of chemistry.

MAKING THE CASE

Hypochlorous Acid is more sensitive to sunlight - and decomposes much more quickly than it's counterpart hypochlorite. This means that the more hypochlorous acid, the faster chlorine will burn in the presence of sunlight.

Hypochlorite is more effective at breaking down organic matter that leads to outbreaks of things like algae and bacteria before it forms.

Also, since pH is only setting the ratio between hypochlorous acid and hypochlorites, as one is consumed the other will convert to maintain ratio. This means as hypochlorous acid is burned, hypochlorite will turn into more hypochlorous acid until all chlorine is burned.

This means that maintaining a high pH for maintenance can significantly lower chlorine consumption while preventing algae: less chlorine is susceptible to sunlight requiring less chlorine while still preventing algae.

LIMITATIONS

There are of course limitations: in the presence of a heavy algae bloom a lower pH will be more effective at killing algae with chlorine. However, once the pool is clean continuing to maintain a low pH is gross overkill - leading to unnecessary chlorine consumption.

SHIFTING THE PARADIGM

Originally the Modified Langelier Saturation Index recommend a pH between 7.2 and 7.4. However, large in part to the efforts of Jock Hamilton (founder of United Chemical) and the evidence supporting efficacy of a higher pH, the recommended range was increased to 7.6, validating much of the argument.

Like most things in chemistry and in pools, there must be a balance: when the pool is clean and sanitizer is added regularly, a high pH reduces chlorine consumption while keeping the pool clean. However, in the presence of large blooms of algae, a lower pH makes a bit more sense to get the most out of a shock treatment.

The goal is always to keep a pool clean with the least amount of chemical (and cost) possible.

With this in mind, there is a strong case for maintaining your pH higher.

THE SECRETS OF

11	35
Na	Br
Sodium	Bromide

Find out how it works and why we've stuck with it in our algaecides since we introduced it in 1983.

United Chemical pioneered the use of Sodium Bromide as an algaecide with our first product, Yellow Treat® in 1983. And it remained one of our secret ingredients until the EPA required its disclosure on packaging in the 1990's. Soon after, competitors began offering their own generic sodium bromide based algaecides as it grew into it's own category. So what's so special about sodium bromide, and why have we stuck with it for so many years?

What is Sodium Bromide?

Sodium Bromide (NaBr) is a bromine salt, and is our preferred method for delivering bromine into pools. Bromine has long been used as an algicide in both indoor pools and hot tubs. In hot tubs it's favored for its stability at higher temperature. For indoor pools, its advantages are that it produces less noxious odors and is less caustic to surfaces outside the water. Its limitations are that it cannot be stabilized in sunlight, hence why chlorine has remained king of the outdoor pool.

Why does it work?

Chemically Bromine acts very similar to chlorine, since they are both halogens. It forms Hypobromous Acid (HOBr) that acts as a powerful algaecide. However, it is less pH dependant than chlorine in how much active bromine is produced.

However, the true secret of Bromine's effectiveness is how it interacts directly with chlorine. Bromine acts as a reducing agent on chlorine, donating it electrons. The result breaks apart chlorine compounds to release pure chlorine as hypobromous acid is produced. As hypobromous acid is consumed, chlorine resumes as as normal, giving the benefit of two sanitizers at once. And since it breaks apart chloramines, it virtually eliminates shocking.

In addition, bromine reacts directly with chlorine to form a powerful oxidizer ChloroBromide (ClBr). This powerful oxidizer destroys all organic material in the pool before quickly dissipating into its constituent chemicals.

What's the drawback?

Although beneficial, it's not perfect. One drawback of Bromine is that the same reaction that makes it a powerful algaecide and oxidizer can interfere with chlorine tests. Since it breaks down chlorine compounds, it can break down the reaction of the test reagent has with chlorine - giving a false "zero" reading. This can be mitigated by letting the test sit for 5 minutes, or using an OTO test.

However, this is most prevalent when using generic, or pure, Sodium Bromide. In fact our newest generation of algaecides solved the chlorine issue with our new formula, while also being much more powerful. This gives all the benefits of Sodium Bromide, while eliminating its drawback.

What's Different about United Chemical's?

All United Chemical algaecides have special formulations that are designed to improve their efficacy as an algaecide as well as offering ancillary benefits. Most competitors attempt to sell against us with their generic 99% by claiming it's "stronger". However, what they are really saying is that their product is simply pure generic sodium bromide salt repackaged. This doesn't make it stronger - only cheaper.

For comparison, our generation 2 formula Swamp Treat™ is our most powerful algaecide yet, while having one of the lowest percentages of sodium bromide.

Sodium Bromide was once one of our secrets. And that secret is out. Lucky for us - it wasn't our only secret.


UNITED CHEMICAL
NEW
IMPROVED FORMULA
No Mōr Problems®
mk.II
Preventative Algicide
REPLACES CLARIFIER
CUT FILTER TIME BY 50%
WON'T STAIN
INGREDIENTS
Active Ingredient (Sodium Bromide) 33.3%
Other Ingredients 66.7%
Total Ingredients 100.0%
Contains catalysts to improve performance
KEEP OUT OF REACH OF CHILDREN
See back panel for precautionary statements
NET CONTENTS 32 FL. OZ. (1 QT.) 946 ML.

We are proud to introduce...

No Mōr Problems® Mk. II

Preventative Algicide

- **Prevents all types of algae and bacteria**
- **Stabilizes chlorine reading**
- **Eliminates shocking**
- **Acts as a clarifier**
- **Reduces filter cycles**
- **Keeps filter clean**
- **Doesn't cause staining**

We believe in challenging the status quo and raising the bar - even if it's us that set the bar. When No Mōr Problems® was first introduced, we had a clear vision: a pool without algae all season long. We wanted pools to live up to the name of having no more problems.

GREAT COULD BE BETTER

Our flagship product largely accomplished that - but it wasn't perfect. Sure, pools never got algae on No Mōr Problems®, but if you missed a dose you might still get some. Sure you could use a lot less sanitizer, but testing the sanitizer could be difficult. It largely lived up to the name, but it could still be better.

THE BREAKTHROUGH

Then we had our big breakthrough with Swamp Treat™: we discovered a formula that not only solved chlorine reading problems, but also made our algaecides exponentially stronger. We immediately thought of what this could mean for No Mōr Problems®.

No Mōr Problems® mk. II utilizes this breakthrough to not only gaurantee you'll get an accurate strong chlorine reading, but also increases its efficacy as an algaecide. How much more effective is it? When we tested it, we saw a pool stay clean for over a month without filtration or sanitizer after one initial dose.

UNDERSTANDING HABITS

We kept in mind that habits are hard to break, so we also wanted to continue to make it as easy as possible by utilizing the same directions we've all become accustomed to. To use it, there's no need to change what you're doing - keep using it the same way you used old No Mōr Problems®.

LIVING UP TO THE NAME

Now we can truly say our No Mōr Problems® lives up to the name, making pools as easy and inexpensive to maintain as possible with less chemical and less headaches.

Keep your eye out for the change over to our new formula this year.

Swamp Treat™

Rescue Algicide

- **1 lb. treats 20,000 gallons**
- **Results in as little as 24 hours**
- **Will leave chlorine residual**
- **Won't stain**

We believe in every nightmare pool is hiding a dream pool just waiting to be seen. And we want to make that dream a reality as easy and quickly as possible. That's why we have Swamp Treat®. Swamp Treat® is our most powerful algaecide. It's patented formula accelerates chlorine so much that it can turn a dense green pool to clear in 24 hours or less. Even more astonishing than its speed is that it also will leave a chlorine residual, eliminating the need for follow up shock treatments - saving you time and money.

AVAILABLE SIZES:

- 1 LB. BOTTLE
- 25 LB. BUCKET

Yellow Treat®

Rescue Algicide

- **5 ounces treats 10,000 gallons**
- **Reduced shocking**
- **Won't stain**

We believe the more often the same problem occurs, the easier it should be to solve. And few things can be as persistent as yellow algae. That's why we have Yellow Treat®: it was the first product in the marketplace to utilize sodium bromide and is still a mainstay for pool service techs from CA to FL. It's formula is so powerful that just a 5 ounces can treat up to 10,000 gallons. For over 40 years, Yellow Treat® has been the most trusted algae solution on the market - making persistent mustard algae easy to kill.

AVAILABLE SIZES:

- 5 OZ. BAG
- 2 LB. BOTTLE
- 3 LB. BOTTLE
- 25 LB. BUCKET

Green Treat®

Rescue Algicide

- **2 lbs. treats 20,000 gallons**
- **Reduced shocking**
- **Won't stain**

Green algae can be tough, and we think it shouldn't be: that's why we have Green Treat® Green Treat® is one mean, green algae killer - able to wipe out the toughest green algae in one shot. Green algae is common in the Northeast and where pools have too little chlorine. This dense growth of algae can be tough to battle. The powerful formula of Green Treat® is aggressive in attacking green algae, killing it and leaving your pool crystal clear.

AVAILABLE SIZES:

- 2 LB. BOTTLE

Pink Treat®

Rescue Algicide

- **2 lbs. treats 20,000 gallons**
- **Reduced shocking**
- **Won't stain**

Few things are as gross as pink "algae", and we think you should never be grossed out by your pool. A little known fact is that both pink algae and white water mold are actually bacteria. Certain strains of bacteria become resistant to sanitizer – this is where Pink Treat® comes in. This special formula is designed specifically for wiping out bacteria in pools leaving your water clean and fresh - they way it should be.

AVAILABLE SIZES:

- 2 LB. BOTTLE

WHY TOTAL ALKALINITY IS THE PROBLEM AND THE SOLUTION TO STAINING

Learn why this one balancing parameter makes or breaks staining in your pool, and why the way you balance is causing stains.

We get a ton of calls about staining: few things can be as frustrating as a staining problem in your pool. While algae usually can be killed with enough chlorine and a variety of algicides, staining is a bit more tricky.

Metal/mineral stains come from a variety of places: iron can come from well water, fertilizer and debris. Copper can come from plumbing and copper based algaecides. Same for Manganese, Silver, etc. Often, when attempting to test for a metal, there will be a zero result for the stain in question; this is because the stain has already fallen out of the water, meaning testing the water is fairly useless.

So considering all of the above and the numerous factors involved, the first question we ask when helping with stains is "where is the Total Alkalinity".

UNDERSTANDING TOTAL ALKALINITY

Total Alkalinity is the measurement of carbonates in solution. This acts as a buffer to pH: when acids are in the water, the carbonates neutralize the acid to form carbonic acid. Carbonic acid is very unstable and decomposes into water and carbon dioxide. Carbon dioxide then gasses off the water. The net result is the pH increases as Total Alkalinity drops, thus fulfilling the action as a buffer.

The (Modified) Langelier Saturation Index recommends a low pH of 7.2 to 7.6 for maximum hypochlorous acid (see the pH Debate). However, to balance against the corrosivity of a low pH, the index also recommends a relatively high Total Alkalinity of 120. This is to prevent the water from dissolving carbonates from plaster, which could lead to etching over time if both the pH and Total Alkalinity is maintained extremely low. And this is where the problem with this balancing method lies.

After all, the Langelier Saturation Index was developed for scaling in pipes. And while it is quite effective, it never took staining into account. Afterall, who cares about staining inside a metal pipe? It doesn't hinder its function, and no one ever sees it. However, pools aren't like metal pipes, and we definitely care about it's aesthetics.

There is one other property that makes Total Alkalinity the deciding factor in staining, and that has to due with solubility rules: carbonates make metals insoluble.

If you look at any solubility chart, you find all those staining and scaling ions - calcium, copper, iron, etc. - become insoluble when they react to carbonates. This means they are likely to drop out and form stains on the surface of the pool. Thus, as Total Alkalinity increases, so does the likelihood for stains.

USING TOTAL ALKALINITY TO TREAT STAINS

Getting the stains off is usually a process of trial and error - finding what works and then using it on all the stains in the pool. However, none of that matters if the stains are doomed to come back because of balancing.

Often when we see recurring staining, we begin by suggesting lowering the Total Alkalinity about 10 ppm to see if staining stops, slows, or even reverts. In cases where staining is significantly bad, we recommend our No Drān™ Acid Wash, which in part involves dropping the Total Alkalinity to zero.

In fact, using Muriatic Acid to remove stains - or to give a stain remover an extra "kick" - works in part due to the fact that Total Alkalinity is being lowered.

PREVENTING STAINS WITH BALANCING

So how do we balance Total Alkalinity to prevent stains? By simply adjusting it based on hardness. The harder the water, the lower the Total Alkalinity should be. The best test to base this on is a Total Hardness test, since it takes into account hardness other than just calcium. However a regular Calcium Hardness test can be used by simply adding 30% to get a rough idea of how high Total Hardness is.

From there, it's simply a matter of balancing the Total Alkalinity accordingly. As hardness increases over time, maintain a slightly lower Total Alkalinity.

For more information on Total Alkalinity balancing, check out the Hamilton Index™


UNITED CHEMICAL
No Drān®
Acid
Wash
REMOVES SCALE & STAINING
TREATS 5K GAL
NO DRAINING NECESSARY
KEEP OUT OF THE REACH OF CHILDREN
POISON
See back panel for additional precautionary statements
NET WT. 32 oz. (2 lbs.) 907.2 g | Sold by weight, not volume

No Drān® Acid Wash

Stain and Scale Remover

- **2 lbs. treats 5,000 gallons**
- **Removes stains and scale**
- **No draining required**
- **Similar results to acid washing**
- **Safe for all surfaces**

We believe in finding the win-win. We like providing choices that also minimize risks. However, when it comes to heavily stained pools, this wasn't always a reality.

HARD CHOICES

The choice was often to live with the stains, or do a full acid wash draining the pool. The risks of acid washes can make it a hard decision: how bad will the surface be etched/damaged? What if one of the service techs leaves a footprint? What if the results aren't even? Even worse, some municipalities take the choice away, mandating pools can't be drained. Luckily, there is a third option: the No Drān® Acid Wash.

AN EASY SOLUTION

By utilizing the water in the pool, the No Drān® Acid Wash treats the entire surface to yield results similar to a full drain acid wash with better results: there is less risk to surface etching since acid is not added directly to the surface,there is less risk of damage done by service technicians since they aren't physically walking on the surface of the pool and results are also much more even since the entire surface is being treated at one time. Best of all, it's overall easier to perform than conventional acid wash, requiring much less labor.

RETHINKING THE KIT

The No Drān® Acid Wash has been around for some time, and was first introduced as kits containing the chemicals and directions necessary to perform the process. However, we soon discovered that most service pros utilized the directions and key ingredients to come up with their own kits.

We looked at this as an opportunity to rethink the process, and make it both more universal and easier to perform. The result is delivering our breakthrough process on an easy to read label wrapped around the primary component of a No Drān® Acid Wash.

THE WIN-WIN OPTION

The No Drān® Acid Wash gives the results of acid washing with less risk and less work and creates an option in areas where draining isn't an option.

Pool Stain Treat®

Stain Remover + Preventative

- **2 lb. treats 20,000 gallons**
- **Keeps salt cells clean**
- **Prevents for up to 60 days**

We understand your time is valuable: you don't have time to look through 50 different products to find the one that works on your stain. You need something strong enough to take out the guess work. That's why we have Pool Stain Treat® - the most effective stain remover in the pool industry. t's powerful chelating and sequestering formula removes all types of metal/ mineral stains from any surface. It's such a strong stain remover that it keeps stains from coming back for as long as 60 days after use.

AVAILABLE SIZES:

- 2 LB. BOTTLE
- 5 OZ. SPOTTING BAG
- 25 LB. BUCKET

Super Stain Treat®

Stain Remover

- **2½ lbs. treats 15,000 gallons**
- **Fast acting**
- **Works on any stain**

Sometimes conventional methods don't cut it - and something unconventional is needed. We believe in providing the unconventional - the "Super" - and that's where Super Stain Treat™ comes in. Super Stain Treat™ is a unique formula that attacks stains in a very different way. Plus, it works in every type of pool. Super Stain Treat™comes to the rescue where conventional stain removers fail.

AVAILABLE SIZES:

- 2½ LB. BOTTLE

Citrus Treat™

Stain Remover

- **2 lbs. treats 20,000 gallons**
- **Completely non-toxic**
- **All natural formula**

We get it: you want to get rid of stains but want something that is easy, safe, non toxic, and made by mother nature. That's why we have Citrus Treat™; it's an all natural stain remover that is safe for you and the environment. It's also mild enough to be used on any surface without being diluted. Safe for your pool, your family and the environment.

AVAILABLE SIZES:

- 2 LB. BOTTLE

Cobalt Cure®

Stain Remover

- **2 lbs. treats 7,500 gallons**
- **Specifically formulated for fiberglass**
- **Prevents staining**

We believe Fiberglass should live up to it's promise of being an easy surface to take care of. However, cobalt staining can turn fiberglass into an eye-sore. Cobalt Cure® is specifically for "cobalting"; the phenomenon where cobalt is leached from the resin of fiberglass. Cobalt Cure® will remove these spots in 3 days or less without draining.

AVAILABLE SIZES:

- 2 LB. BOTTLE

SAY Hi TO THE FIRST INDEX FOR POOLS

Learn the science behind the Hamilton Index™ and what makes it the superior way to balance pools.

Back when Jock Hamilton serviced pools, he began to notice something; pools that were supposedly balanced still managed to stain, scale, and get algae. He then asked the important question "Why?" Thus began his journey to develop the first index for pools, called the Hamilton Index™. So what makes it better, and why? Here we retrace the steps and science behind Jock's big breakthrough.

The Langelier Index (LSI)

Wilfred Langelier developed his breakthrough index in the 1930's as a means of predicting calcium solubility in water pipes. The challenge at the time was scaling in municipal pipes which would impede water flow. Wilfred's index not only predicted when a pipe was likely to scale, but also gave a means for prevention. Focusing on pH as the primary parameter, municipalities could simply adjust the pH to prevent pipes from scaling.

The pool industry quickly adopted the index since it provided a means of balancing to predict chemical behavior in the pool.

Over the years, modifications were made to take into account the sanitation factors in the pool, determining a preferred pH range of 7.2 to 7.4, then later 7.2 to 7.6.

Limitation of the LSI

While a major breakthrough at the time, the LSI was never intended for application outside that of pipes. When applied to a very different system, such as pools, there are certain additional factors that the LSI doesn't take into account.

Open vs Closed

First, a pool is an open system while a pipe is a closed system. In pools, when an acids are neutralized by Alkalinity, the net resulting reactions yield water and CO2. The CO2 is then gassed off, leading to a rise in pH and drop in Total Alkalinity.

However, in a closed system like a pipe, CO2 can't be gassed off and is forced back into solution. This is a major difference that affects the solubility of compounds.

Also, the number of compounds that can be introduced into an open system is much greater than a closed system. In a closed system - such as pipes - the source water is the major factor. However, in an open system like pools, there are many more factors; rain, wind, surrounding soil, swimmer contaminants, etc.

Aesthetics vs Functionality

Another consideration never taken into account by the LSI was that with pools we care not just about functionality but also aesthetics; we care about stains - not just scale.

If staining occurs inside a pipe - no one really cares. Nobody will see the inside of a pipe, and as long as the metal deposit doesn't impede function, you might not even know it is there. Pools on the other hand must also take into account aesthetics: while a stained pool functions the same, most people don't like seeing stains.

This means that metal solubility - the source of staining - was never a major consideration of the LSI.

Sanitation

Sanitation wasn't a factor either of the LSI - at least not in the context of a pool. A pool is a much more stagnant body of water versus water flowing through a pipe. In addition, the water in a pipe is shielded from sunlight while water in a pool is not.

This is why the LSI was needed to be modified for pool use; the pH range was limited to ensure adequate sanitation while keeping the index below saturation levels. And since pH was the determining factor in the LSI, the limitation of an acceptable pH range reduced the the flexibility of the index (see "The pH Debate").

Starting from Scratch

Jock Hamilton recognized these challenges of using the LSI as a service technician. Taking it upon himself, he began studying chemistry and analyzed the conditions pools operate within. He used his Service Tech background to develop a practical system for balancing tailored to the factors of pools. Thus was born the Hamilton IndexTM.

Focusing on Total Alkalinity

SOLUBILITY RULES

The below chart illustrates solubility rules for various compounds.
Legend: S= Soluble, Ss= Slightly Soluble, I= Insoluble.
Note: Black Box Higlighting is ours.

	Bromide Br^-	Carbonate CO_3^{2-}	Chloride Cl^-	Chlorates ClO_3^-	Hydroxide OH^-	Nitrate NO_3^-	Oxide O^{2-}	Phosphate PO_4^{3-}	Sulfate SO_4^{2-}	Dichromate $Cr_2O_7^{2-}$
Aluminium Al^{3+}	S	X	S	S	I	S	I	I	S	I
Ammonium NH_4^+	S	S	S	S	S	S	X	S	S	S
Calcium Ca^{2+}	S	I	S	S	sS	S	sS	I	sS	I
Copper(II) Cu^{2+}	S	I	S	S	I	S	I	I	S	I
Iron(II) Fe^{2+}	S	I	S	S	I	S	I	I	S	I
Iron(III) Fe^{3+}	S	X	S	S	I	S	I	I	sS	I
Magnesium Mg^{2+}	S	I	S	S	I	S	I	I	S	I
Potassium K^+	S	S	S	S	S	S	S	S	S	S
Silver Ag^+	I	I	I	S	X	S	I	I	sS	I
Sodium Na^+	S	S	S	S	S	S	S	S	S	S
Zinc Zn^{2+}	S	I	S	S	I	S	I	I	S	I
	Bromide Br^-	Carbonate CO_3^{2-}	Chloride Cl^-	Chlorates ClO_3^-	Hydroxide OH^-	Nitrate NO_3^-	Oxide O^{2-}	Phosphate PO_4^{3-}	Sulfate SO_4^{2-}	Dichromate $Cr_2O_7^{2-}$

Source: Wikipedia.org

Rather than focus on pH, Jock found direct correlation between Total Alkalinity and Staining. Total Alkalinity measures carbonates. And carbonates turn metal compounds insoluble (see Alkalinity is the Problem and Solution on page…) Using empirical data from his service pools, he developed an algorithm to predict staining based on Total Hardness. He chose Total Hardness since it includes hardness beyond simply calcium hardness.

For Plaster: f(TH)=-20ln(TH)+195, for Non-Plaster: f(TH)=-20ln(TH)+185
Where f(TH) is the Total Alkalinity staining threshold.

Note: the difference in surface is that plaster contains carbonates that are released into water. This gave a way to predict staining in a much linear fashion. Simply put, when the actual Total Alkalinity exceeds the threshold Total Alkalinity, probability of staining increases dramatically. When these values are equal, staining may occur. However, as long as the actual Total Alkalinity stays below the threshold, staining is avoided. We can use a similar format to the LSI to express this.

f(TH) = TAthreshold,

- If TA_{actual} - $TA_{threshold}$ > 0, water will be supersaturated; staining likely to occur

- If TA_{actual} - $TA_{threshold}$ = 0, water will be saturated; staining may occur
- If TA_{actual} - $TA_{threshold}$ < 0, water will be undersaturated; staining unlikely to occur
-

With insight into the correlation between Total Alkalinity, Total Hardness, and Staining, we then need to address pH.

The Role of pH

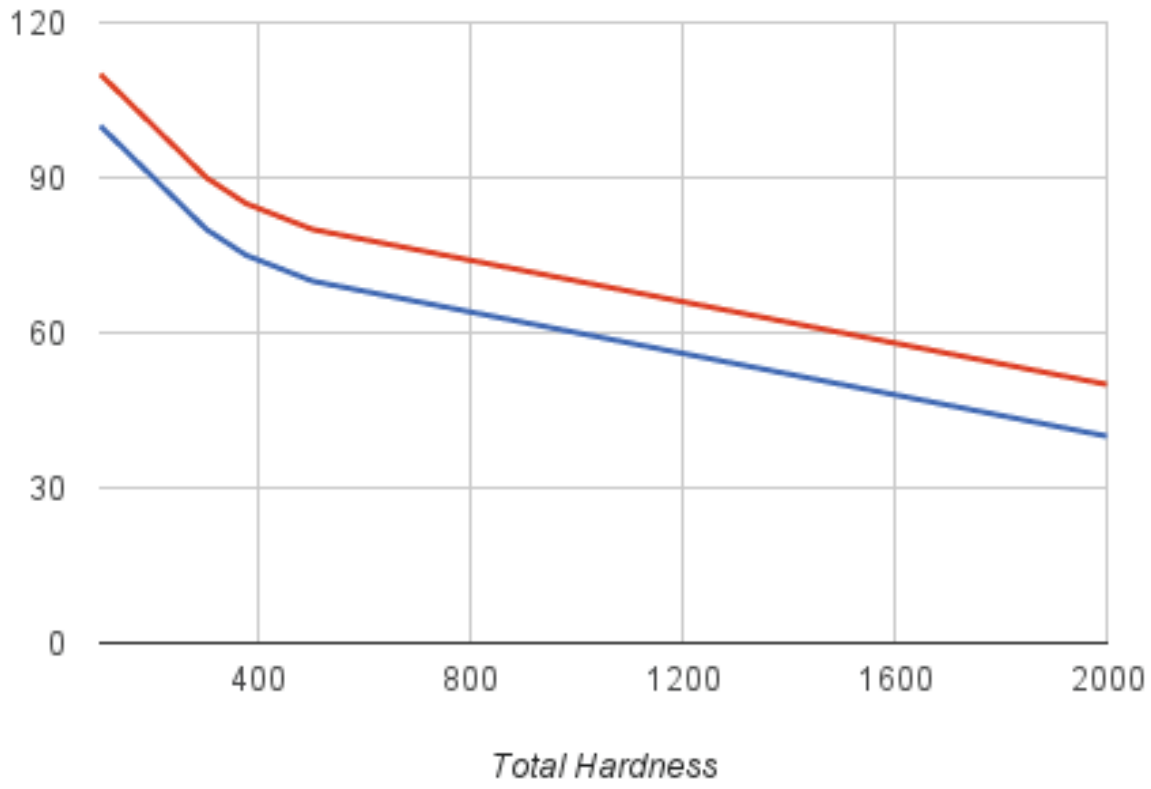
Jock believed that a high pH improved sanitizer efficiency for maintenance by reducing chlorine loss from UV light (see "The pH Debate").

In addition, Jock understood that if we were to maintain both a low pH and low Total Alkalinity, we increase the corrosivity of the water and likelihood of etching a plaster surface (by dissolving calcium carbonate).

It's also worth noting that pH will naturally increase in a pool overtime: a pool will natural trend to a high pH as Total Alkalinity continues to neutralize acids in water. As this happens, Total Alkalinity itself is lowered. This is due to a pool being an "open system", allowing CO_2 to be gassed out of solution.

TOTAL HARDNESS VS. TOTAL ALKALINTY

The below chart illustrates the relationship between metal saturation and alkalinity depending on hardness level. The red series is non-plaster surface, and the blue series is plaster surface. When alkalinity rises above the threshold, staining is likely to occur.



BALANCING IS EASY AS 1-2-3

Rather than forcing users to use a complicated equation, the Hamilton Index is expressed as a simple chart.

1. **Test your hardness (Total Hardness is recommended, but Calcium Hardness estimates are included for convenience.**
2. **Adjust Total Alkalinity below the max value. Plaster pools should be maintained 10 ppm lower vs other surfaces.**
3. **Maintain pH between 7.8 to 8.2, avoiding going below 7.6.**

This makes maintaining a high pH sensible - especially if we are to focus on Total Alkalinity.

However, Jock limited the upper pH range to 8.2, since at 8.3 Calcium becomes very insoluble and can lead to scaling.

Making it practical

Jock went one step further with his findings. He understood that usability of the index is also important factor. He knew few people would carry with them the graphing calculator needed to make all these complex calculations to find threshold values.

Instead he made it as simple as possible, expressing the Index as a chart. By finding the Total Hardness value, you could see what the Total Alkalinity threshold is, and where to maintain Alkalinity below.

We have included Calcium Hardness estimates to increase usability. Although Total Hardness is preferred, Calcium Hardness tests are more common. The value of Calcium Hardness is estimated as approximately 70% of the value of Total Hardness.

Summary

The beauty of this approach is that it focuses on the unique factors of the pool environment.

Rather than "forcing a square peg into a round hole", the Hamilton Index™ embraces the natural tendencies of a pool with small adjustments to get the best results. The results are a stain-free, algae-free pool that requires dramatically less chemical to maintain.

HAMILTON INDEX™ WATER BALANCING SYSTEM	1. TEST HARDNESS IF HARDNESS LEVEL IS...		2. ADJUST ALKALINITY MAINTAINT TOTAL ALKALINITY BELOW...	
	(ESTIMATED) CALCIUM HARDNESS PPM	(ACTUAL) TOTAL HARDNESS PPM	PLASTER MAX. TOTAL ALKALINITY PPM	NON-PLASTER MAX. TOTAL ALKALINITY PPM
	70	100	100	110
IDEAL HARDNESS RANGE	**105**	**150**	**95**	**105**
	140	**200**	**90**	**100**
	175	**250**	**85**	**95**
	210	300	80	90
	260	375	75	85
	420	500	70	80
	525	750	65	75
	700	1000	60	70
	1050	1500	50	60
	1400	2000	40	50
3. ADJUST AND MAINTAIN pH	MINIMUM **7.8**		MAXIMUM **8.2**	NEVER BELOW **7.6**

No Mor Muriatic Acid™

pH + Alkalinity Reducer

- **2½ lbs. is equal to 1 gallon of acid**
- **No fumes or harmful spills**
- **Safer and easier to handle**

We believe taking care of your pool should be safe and easy. And there's nothing safe or easy about liquid acid. That's why we have No Mor Muriatic Acid™ - so you can say goodbye to using liquid. While other products reduce only the pH or alkalinity only, No Mor Muriatic Acid™ reduces both equally just like muriatic acid, except with no more fumes, no more bottle deposits and no more storage hassles.

AVAILABLE SIZES:

- 2.5 LB. BOTTLE

Cal Treat™

Calcium Hardness Reducer

- **2½ lbs. treats 15,000 gallons**
- **Filters out calcium**
- **No draining necessary**

You should have the ability to take full control of your balancing, while not spending an arm and a leg. However, the only solution to lowering Calcium Hardness was draining and refilling - an expensive pain. Cal Treat™ removes the expense and the pain. When applied as directed, Cal Treat™ will reduce calcium levels between 200 - 400 ppm and help prevent calcium scale formation on pool surfaces and pool equipment.

AVAILABLE SIZES:

- 2½ LB. BOTTLE
- 25 LB. BUCKET

Start Up Treat™

New Plaster Pool Start-Ups

- **2 lbs. treats 20,000 gallons**
- **Prevents staining**
- **Removes plaster dust**
- **Safe for all finishes**

We think that the last step to a new pool should be a relief and not another headache. However, there are metals present in the water and Carbonates are introduced into the water as part of the curing process which turns your beautiful new pool into a stained one. This is where Start-Up Treat™ comes in: it binds metals and calcium into less reactive highly soluble compounds - preventing stains and removing plaster dust. The result is an easy start to a beautiful pool.

AVAILABLE SIZES:

- 2 LB. BOTTLE

Easy Acid™

Alkalinity Reducer

- **2 lbs. treats 7,500 gallons**
- **Lowers Alkailinity with little affect on pH.**

We believe balancing should be as easy and direct as possible - including lowering your alkalinity. Easy Acid™ has the same strength and better alkalinity control than a gallon of muriatic acid. 2 1/3 lbs. of Easy Acid™ equals 1 gallon of muriatic acid for alkalinity control. Easy Acid™ is safe to use, takes up less storage and fumes are virtually eliminated. Easy, direct and safe.

AVAILABLE SIZES:

- 1 LB. BAG
- 45 LB. BUCKET

Easy pH™

pH Increaser

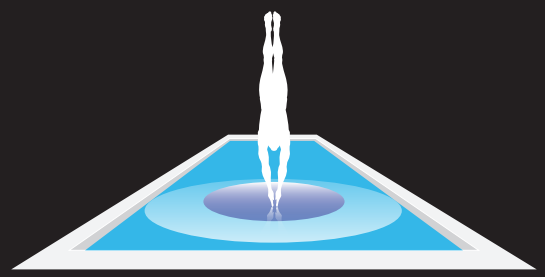
- **6 ounces is equal to 1 lb. of Soda Ash**
- **Raises pH with little affect on Alkalinity**

Few things can be as hard as balancing pH against alkalinity - and we think it shouldn't be. That's why we have Easy pH™. Unlike other pH increasers that deposit carbonates in your pool water, Easy pH™ has a unique formulation that contains no carbonates and only requires 6 oz. to do the same work as 1 lb. of the typical "pH increaser" product. Packaged in pre-measured 6 oz. bags for easy application.

AVAILABLE SIZES:

- 6 OZ. BAG

BALANCERS - NO MOR MURIATIC ACID™ - CAL TREAT™ - START UP TREAT™ - EASY ACID™ - EASY PH™



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