EICF 2025 Liverpool

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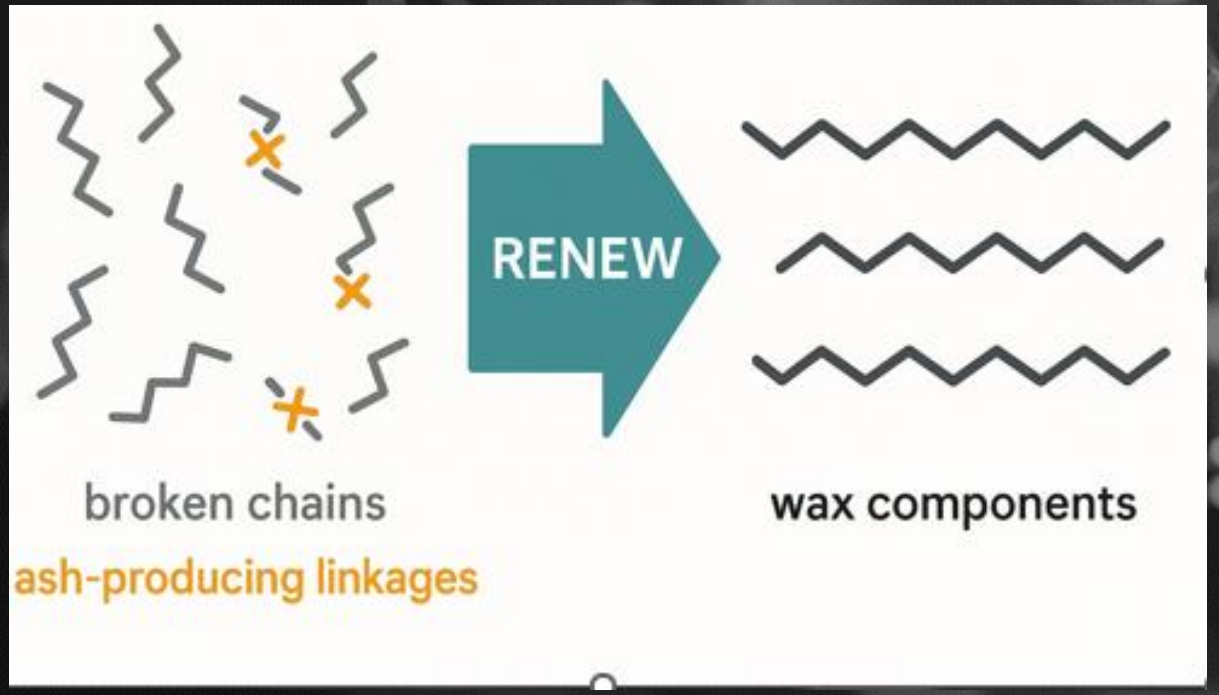
RENEW PROCESS

RENEW WAX RECONSTITUTION TECHNOLOGY



BENEFITS OF RENEW PROCESS

IDEAL FOR HIGH END AEROSPACE AND IMPLANT FOUNDRIES

REDUCED ASH CONCENTRATION

ELIMINATION OF SIDE REACTIONS

ADDITIONAL FORMULARY MATERIALS

RESTORE CARBON CHAINS

INCREASE CPK

PROBLEMS OF

CONVENTIONALLY RECLAIMED WAX

Classical reclamation is only physically separating the wax from solids and has disadvantages as you can see in the next foils whereas RENEW is renewing the wax on a moleculare level and re-virginizing it and not separating a compound

Boiler Treatment and poor water treatment are rare but extremely dangerous causes of ash. Sodium, potassium, phosphorous, calcium and manganese are the culprits that are easily removed from this source of wax contamination by RENEW.

Some of these elements cause ash multiplication after the burn out cycle. Phosphorous, after decomposing from its organic boiler treatment compound during burnout, bonds with oxygen in the air to produce phosphorous pentoxide in the shell. This means for every 0.0030 of phosphorous in the ash, you automatically gain an additional 0.0080 of ash after the burnout is complete.

DISADVANTAGES OF CONVENTIONALLY RECLAIMED WAX

🔄 **1. Degradation of Wax Properties**

Repeated high temperature boiling and cooling alters the **molecular structure** of the wax.

•This leads to changes in:

- **Melting point**
- **Viscosity**
- **Shrinkage behavior**

Poor consistency = poor pattern quality = more casting defects.

However modern reclamation processes like vacuum drying implemented at MORSA avoid these affects mostly.

DISADVANTAGES OF CONVENTIONALLY RECLAIMED WAX

🌡️ 2. **Thermal Decomposition**

Overheating wax during reclamation can cause thermal degradation. Produces volatile compounds and can affect the wax's burnout behavior.

🧪 3**. Loss of Additives**

Waxes often contain plasticizers, resins, dyes, or stabilizers.These components degrade or evaporate during reclamation.

Result: The reclaimed wax may no longer match the original spec.

PROBLEMS WITH CLASSICAL RECLAMATION

Classical reclamation often requires additives to stabilize the compound for certain properties During Autoclave dewax process

About 10 % of the wax compound is burned and therefore the compound can become inconsistent with the original base if not the same components that are burned are being added.

To provide a mathematic example what this means :

If **10%** of something is **burned each cycle**, you're essentially using up a fraction of the whole repeatedly.

So you're not just subtracting 10% linearly each time (i.e., 10%, 20%, 30%, ...), because that would assume that you're always using 10% of the original total.

But **if you're using 10% of what's left each cycle**, then it's a **decaying exponential process**, like this:

- After 1 cycle: 90% remains
- After 2 cycles: 90% of 90% = 81% remains
- After 3 cycles: 90% of 81% = 72.9% remains... and so on.

If **10% is replaced each cycle**, then you're not replacing a fixed portion of the original — instead, you're gradually reducing what's "unrenewed".
That follows an exponential decay curve:

The formula for the remaining amount af

$$(0.9)^n = 0.01 \Rightarrow n\log(0.9) = \log(0.01) \Rightarrow n = \frac{\log(0.01)}{\log(0.9)} \approx \frac{-2}{-0.045757} \approx 43.7$$

R=(1−0.10)nR = (1 - 0.10)^nR=(1−0.10)n
Where:
- RRR = fraction of original remaining
- nnn = number of cycles

THE CHEMISTRY BEHIND THE RENEW REPROCESS

DEVELOPED FOR CRUDE OIL REFINERIES

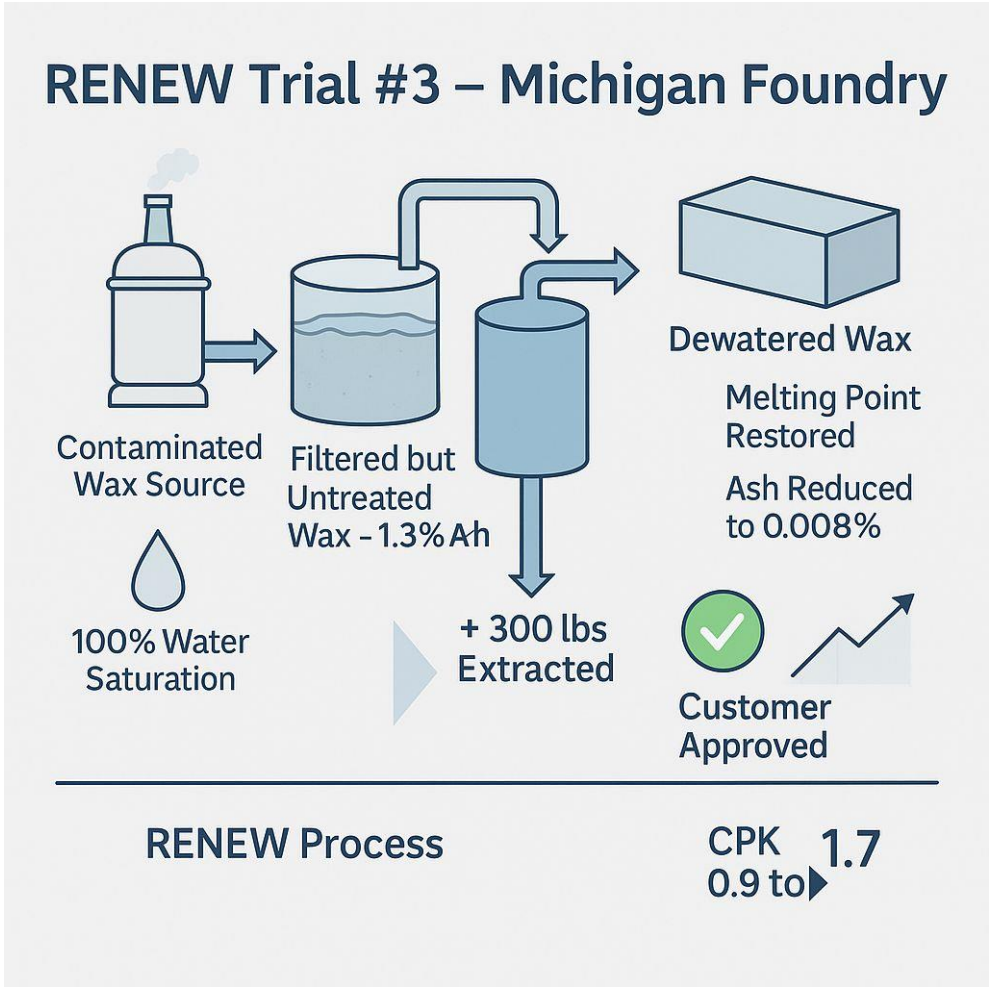
Carbon Chain Break Down

Like Oil In Your Car
Thermal Destruction
Time Related Oxidation

In Line Exchange of Oxides/Organometalics/metalics/Salts
In Line Exchange of Mediums

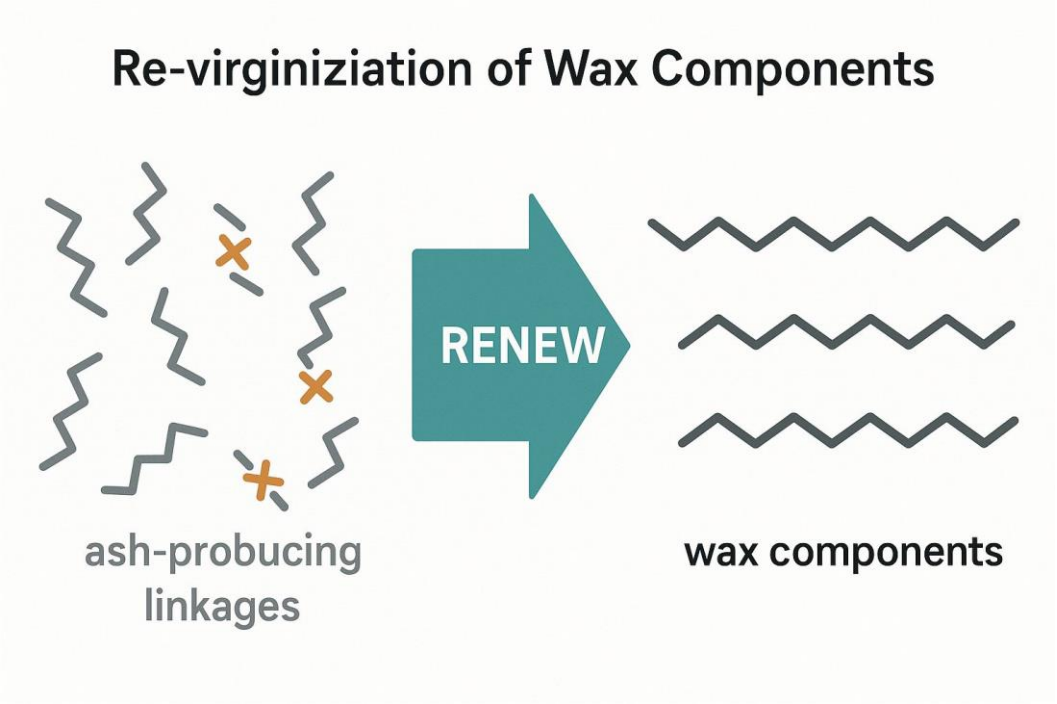
Restoration of Reaction Kinetics
Restoration of Raw Material Mass Balance

TO REDUCE SULPHUR EMISSIONS



RENEW PROCESS AND HOW IT WORKS

HOW IT IS DIFFERENT TO RECLAMATION



The re-virginization of the wax components is possible as RENEW can remove the ash producing linkages that join onto the broken hydrocarbon chain ends. Renew can then reattach carbon chain fragments to each other and restore the physical characteristics of each of the individual components of the wax. This is an oversimplified explanation of the actual reaction kinetics that take place in the process. However, the linkages that are restored by RENEW are the same as the ones that occur during the formation of the carbon chain structures that compose the resins used to make IC waxes. The linkages and formations of carbon chains are not new technology or information to the people who make hydrocarbons. In fact, these reactions follow very specific steps and rules that have been commonly known in their art for the last 50 years

AT THE CORE OF THIS PERFORMANCE RESTORATION LIES RENEW'S ABILITY TO **REJUVENATE DEGRADED HYDROCARBONS**

The process selectively removes **ash-producing linkages** and oxidized fragments that form at the termini of broken hydrocarbon chains.

It facilitates **controlled reattachment of carbon chain fragments**, mimicking the natural polymerization steps used during the manufacture of hydrocarbon-based resins.

As a result, the wax's physical characteristics—such as thermal stability, flow behavior, and shrinkage control—are effectively returned to a **virgin-equivalent state**.

While the explanation above simplifies the underlying **reaction kinetics**, it is important to note that the **mechanisms involved in chain scission, purification, and re-polymerization** align with well-established principles in hydrocarbon chemistry. These reaction pathways have been widely understood and applied in petrochemical and polymer industries for over five decades.

WHY WOULD THEY DO IT?

1. Not 1 material made for IC Casting
2. Only 1 test ever made for IC Casting (AEM)
3. Nobody Cares about us
4. Cost-Availability

What Makes a Good Casting:

- Good pattern Surface, Dimension, Flatness
- Repeatability
- CTE
- Thermodynamics
- Removal- How and When?
- Residual Ash
- Cost

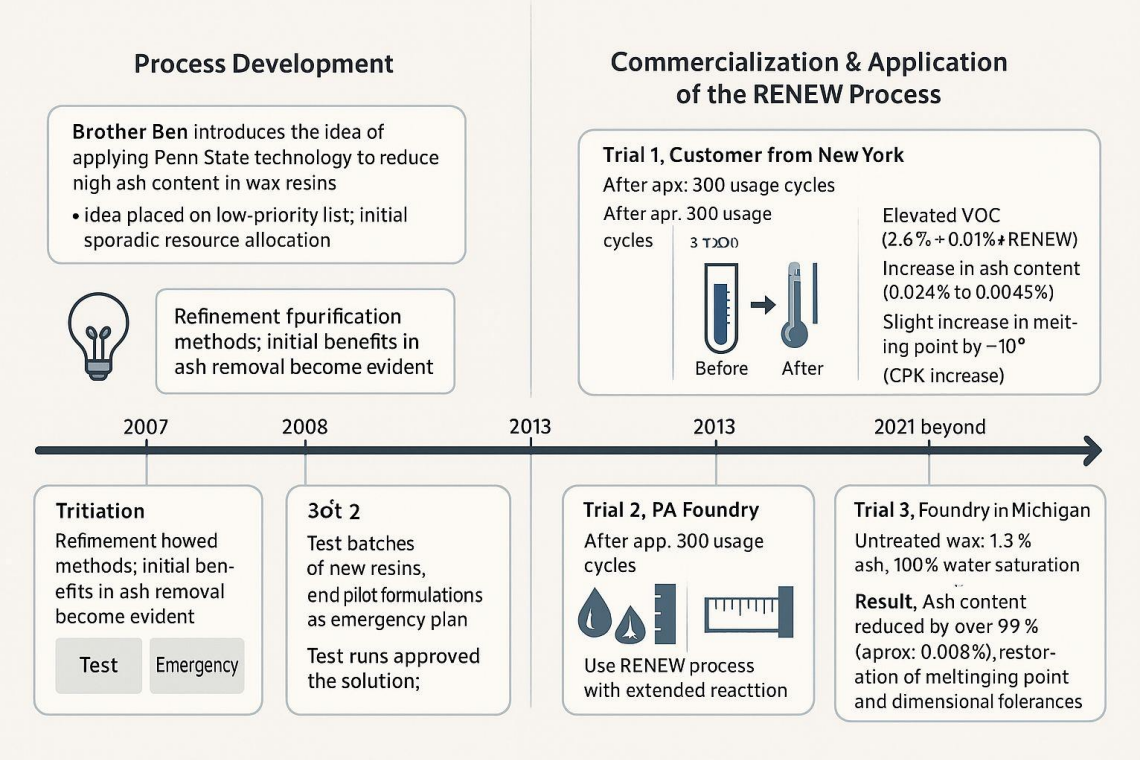
COMMERCIALIZATION, TRIALS & APPLICATION OF THE RENEW PROCES

13 years ago, one of our customers in NY State came to us with an insurmountable problem. They were using the same virgin pattern wax for 15 years.

We were doing the recon to sprue for the last 7 of those years. Suddenly the customer provided formula for the sprue did not work. Nothing would drop the melting point of the material, and the residual ash had doubled. We analyzed the wax and found no unreasonable changes in composition with respect to resin and wax content with an IR. We ran GCMS on the wax and then again on the wax ash. We discovered materials that were not traditionally found in IC wax and other materials that have always been deliberately avoided by IC wax makers.

We have seen these effects from boiler treatment contamination scenarios in the past, but after an onsite inspection and testing battery, we found this was not the source of the problem. We then looked at the virgin pattern wax. We ran all of the standard tests on the wax base, and as provided, it was within specification limits. We tested retained samples from previous lots of sprue wax in the same way and they showed no problems. When we mixed them together, the combination, upon reheating, showed no problem. However, when we added water to emulate the autoclave, the combined wax melting point increased to match the pattern wax. Successive reheat cycles elevated the melting point an additional 4 degrees. We repeated this test using distilled water and saw the same results. We then isolated our problem and identified the decomposition that caused it. We applied our RENEW reaction to the material and reduced the melting point 10 degrees of the 12-degree increase. The customer approved the solution. From 2010 to 2013 when I left Pennsylvania Wax Corporation, we processed over 275,000 lbs of sprue wax with no adverse effect at the customer site

RENEW PROCESS DEVELOPMENT



A. Process Development Phase

1. Initiation (approx. 20 years ago)

   “Brother Ben introduces the idea of applying Penn State technology to reduce high ash content in wax resins.”

2. “Idea placed on low-priority list, initial sporadic resource allocation.” Development Phase (2007 – 2009)

3.

   • 2007:
   “Refinement of purification methods; initial benefits in ash removal become evident.”

   • 2008:
   “Test batches of new resins and pilot formulations as an emergency plan; test runs on standard resins.”

   • 2009:
   “Achieved disaster recovery level: Secondary sourcing for all used resins.”

FIRST 3 TRIALS SINCE 2010

Trial 1 – Customer from New York (approx. 2010)After approx. 300 usage cycles:

- Sprue wax showed doubled ash content and increased melting point despite correct ingredients.
- Applied the RENEW process → Melting point reduced by approx. 10°C.
- Customer approved solution; over 275,000 lb of sprue wax process

Trial 2 – PA Foundry (2013)After approx. 300 usage cycles:

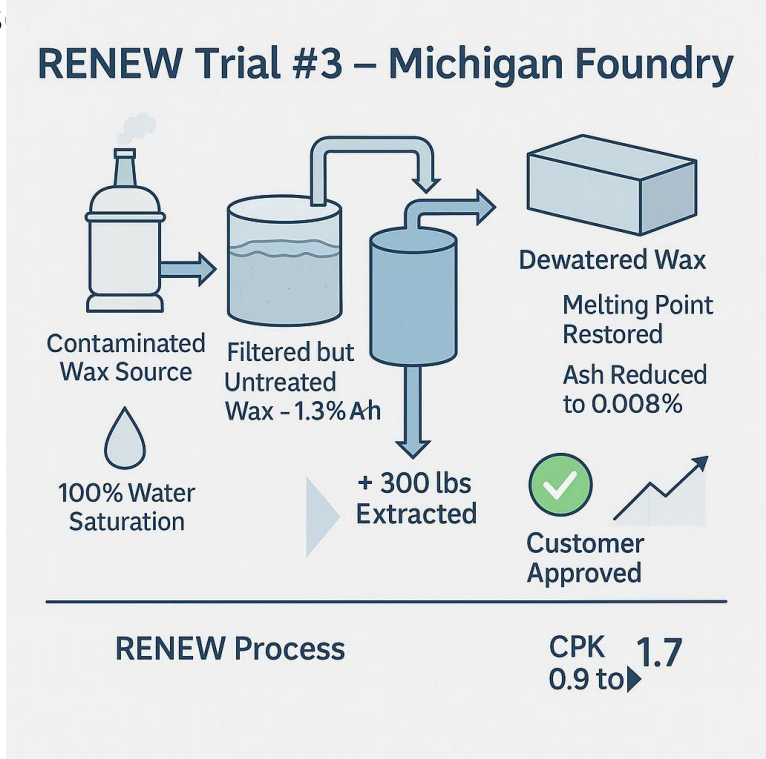
- VOC reduced from 2.6% to 0.01%
- Ash content reduced from 0.024% to 0.0045%
- Slight increase in melting point
- Minor improvement in dimensional tolerance (CPK increase)
- RENEW process applied with extended reaction

Trial 3 – Foundry in Michigan (2021 and beyond)

- Untreated wax: 1.3% ash, 100% water saturation
- RENEW process applied for 30 hours on 2,000 lb of dewaxed wax

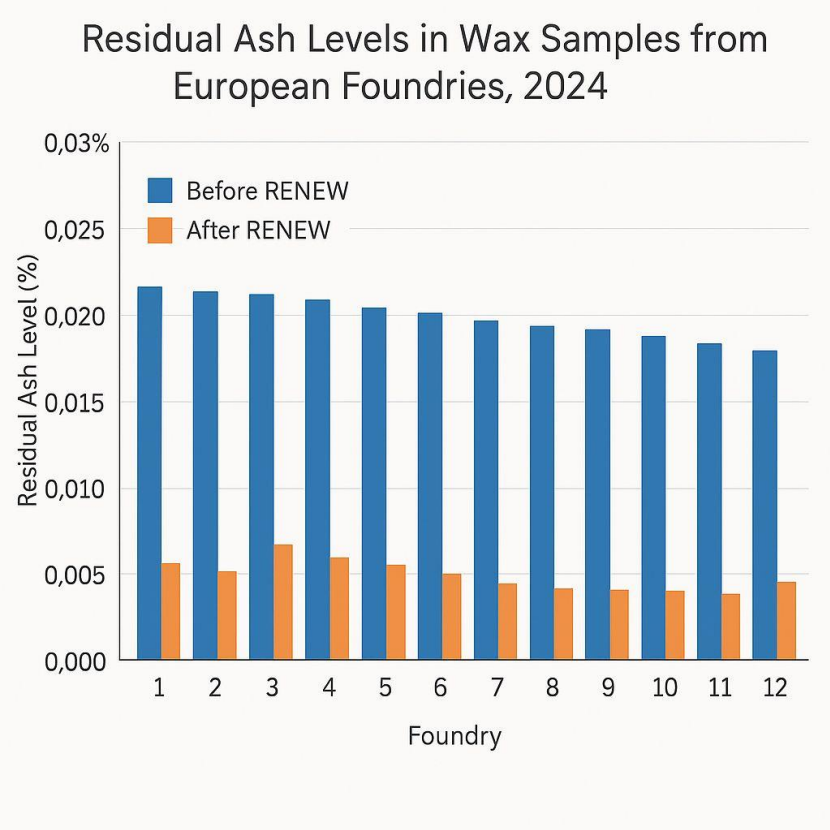
Extracted over 300 lb (15%) of salts

- Ash content reduced by over 99% (to approx. 0.008%)
- Melting point and dimensional tolerances restored



EUROPEAN MARKET AND ADDITIONAL BEENFITS OF THE RENEW APPLICATION

Comparative analysis of Conventionally reclaimed wax to RENEW :



Finally, my analysis of wax samples from 12 European foundries in 2024 has shown me another unexpected need for the RENEW application. While all 12 of these wax systems had ash levels over .02% and an average of .029% it seemed to be commonly accepted in the industry. 9 of these wax systems, represented by 11 unique virgin pattern waxes, all demonstrated what seemed to be randomized cracking issues. 8 of these 11 pattern waxes demonstrated boiling of the virgin wax at a temperature range from 110-140 C. These waxes were being used in conjunction with 12 reclaimed runner bar (sprue) waxes. 11 of the 12 waxes demonstrated rolling boil over the standard 104 C expected temperature. All 11waxes rolling boiled to 127 C and continued boiling to 137 C.

At the termination of active boiling, the samples would spontaneously spit wax in a violent reaction normally indicating the presence of water generated by a side reaction of a wax component. 8 pattern waxes and 10 runner bar waxes resisted melting point change when additized by normal industry standard materials used since 1942. Each of these waxes were analyzed for Autoclave Expansion Modulus and failed miserably. There was no correlation between melting point, inner phase expansion characteristic or point of evacuation time with any of these materials.

After running these waxes through the RENEW DMP process, the reaction that produced water withing the wax while subjecting it to heat was terminated. Post-termination, all of the waxes responded normally to melting point changing additives and AEM was responding predictably.

Most notably, the average residual ash level of the 18 RENEWed waxes was .008%. At the time of writing this paper, lots of those waxes have gone through production trials and have been successfully used at customer sites.

INTERPRETING RESULTS

Application Scope of RENEW

RENEW process is universally applicable across IC wax types (filled, non-filled, pattern,runner bar).

Most notably, the average residual ash level of the 18 RENEWed waxes was 0,008%.

At the time of writing this paper, lots of those waxes have gone through production trials and have been successfully used at customer sites.

Residual ash after burnout negatively affects all shell types, regardless of alloy or market. Reducing ash levels always benefits the foundry. RENEW wax technology helps create virgin or reclaimed wax with minimal organic and metallic contaminants. In tests, RENEW reduced ash by over 80% after 300–500 reclaiming cycles—even in older systems.

Ash can also come from poor boiler water treatment, introducing elements like sodium, potassium, phosphorous, calcium, and manganese. RENEW effectively removes these. Phosphorous is particularly harmful, as it multiplies ash content post-burnout by forming phosphorous pentoxide.

Vybar (a highly branched alkane used in candle wax) has entered the investment casting wax market with harmful consequences. While it improves pattern appearance, it delays wax flow and increases internal pressure during dewaxing, promoting shell cracking. Vybar's side reactions produce water under heat, causing explosive expansion that worsens cracks.

Moreover, using Vybar in waxes with similar melting points for pattern and runner wax is flawed. If Vybar is needed, the formulation is already thermodynamically unsound. RENEW mitigates this by terminating reactive branches, preventing water formation and restoring proper melting behavior for clean dewaxing without cracks.

THE GOOD, THE BAD AND THE UGLY

BRANCHED ALKANES

ARTIFICIAL MELTING POINT

VOLUMETRIC EXPANSION OF SOLIDS AND LIQUIDS IN WAX

THE NEED FOR NEW ANALYSIS METHOD

TEST METHODOLOGY

WHAT TEST PROTOCOLS OR STANDARDS MEASUREMENTS WERE TAKEN ?

AUTOCLAVE EXPANSION MODULUS

- Real time assesment
- Can be used on any wax
- Filled Waxes
- Non-filled waxes
- Real time 3 axis evaluation
- Like looking into your autoclave
- Side by side comparison of pattern and sprue waxes

Evaluates:

- Length increase of capsule
- Time until evacuation
- Material state during evacuation
- Volume of evacuation

IT'S ALL ABOUT BALANCE

Injection Time

Melting Point/ CP

Dimensional Criteria

Fast Setup Relative To Surface Area

Specific Gravity Sedimentation

Cavitation

Heat Capacity

Heat Transfer Out

Dewax Time

Melting Point /AEM

Viscosity

Specific Gravity Ratio AQ/Solid

Residuals

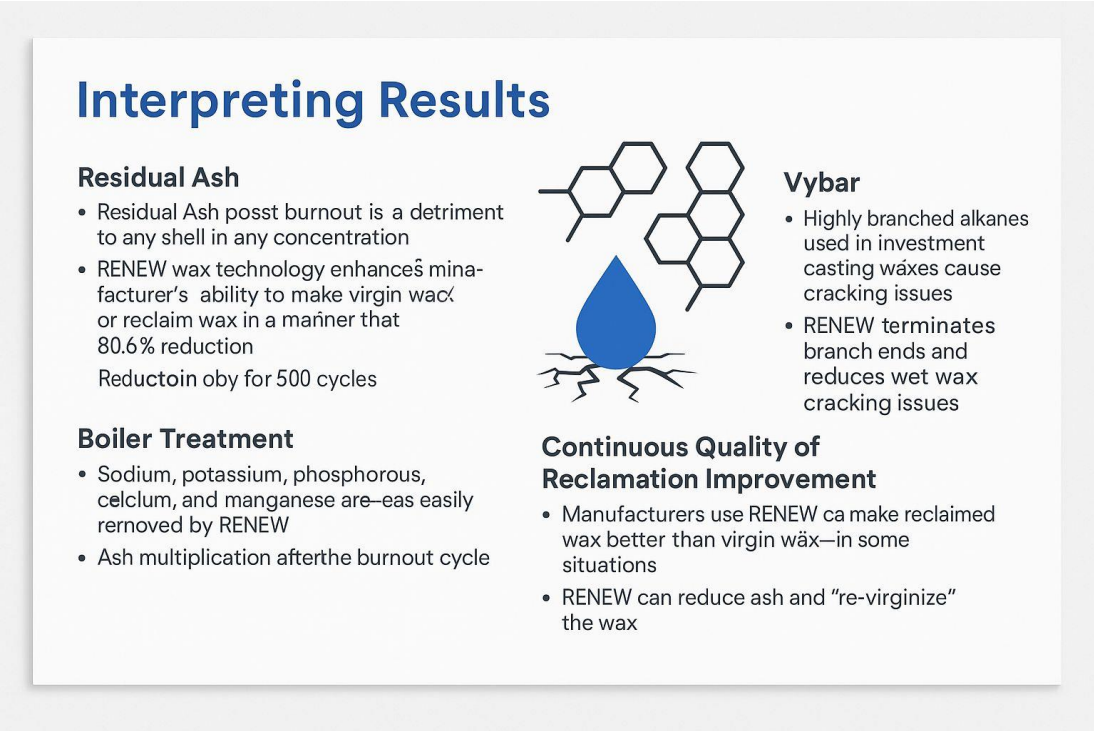
Heat Capacity

Heat Transfer In

Thermal Insulator

RESULTS AND INTERPRETATION

OTHER THEN RESIDUAL ASH SPECIFICATIONS, CAN RENEW MAKE THE RECLAIMED WAX BETTER THEN THE ORIGINAL VIRGIN WAX?



In some situations, RENEW can improve performance of reclaimed pattern waxes to surpass that of the original pattern wax. This is possible in cases where the pattern wax and sprue wax are engineered to be used together in a symbiotic fashion.

It is also possible to improve performance of the reclaim to surpass that of the virgin when the reclaimer uses better grades of additives or more efficient ratios of materials than were used in the production of the virgin pattern wax. In both cases, the RENEW process will rejuvenate the used wax portion back to a virgin state just as if it was a component of his virgin formulation technology.

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CAN RENEW IMPROVE RECLAIMED WAX BEYOND VIRGIN QUALITY?

Beyond achieving low residual ash levels, the RENEW process has demonstrated the capability to restore and, in some cases, enhance the performance of reclaimed pattern waxes beyond that of the original virgin wax. This performance uplift is achievable under two primary conditions:

1. **Symbiotic Wax System Engineering**

When pattern wax and sprue wax are designed to function in a complementary manner, their combined use and subsequent reclamation through RENEW can yield a more consistent and optimized formulation. In this context, the integration of components allows for improved flow, mechanical stability, and dimensional accuracy.

2. **Superior Additive Selection and Rebalancing**

In some cases, the additives and component ratios used during reclamation may exceed the quality or efficiency of those used in the original virgin wax. By incorporating higher-grade materials or optimizing their proportions, RENEW can surpass the baseline properties of the original formulation.

At the core of this performance restoration lies RENEW's ability to **rejuvenate degraded hydrocarbons**:

- The process selectively removes **ash-producing linkages** and oxidized fragments that form at the termini of broken hydrocarbon chains.
- It facilitates **controlled reattachment of carbon chain fragments**, mimicking the natural polymerization steps used during the manufacture of hydrocarbon-based resins.
- As a result, the wax's physical characteristics—such as thermal stability, flow behavior, and shrinkage control—are effectively returned to a **virgin-equivalent state**.

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FINAL TIPS & TAKEAWAYS

Made for Oil Refineries

Introduced 20 years ago

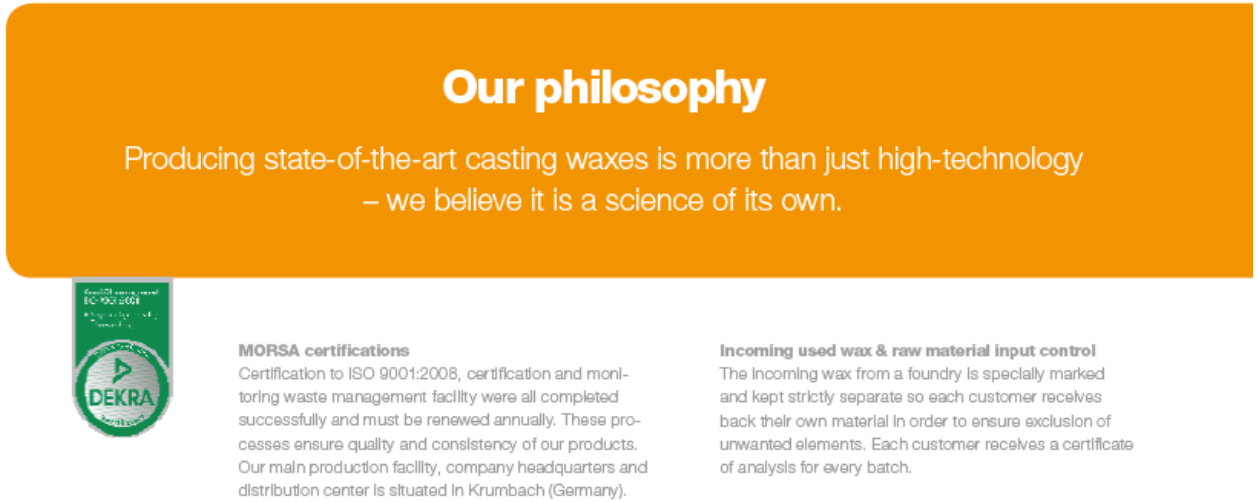
No one else has figured it out yet

Chemistry is just one part of it

It is an Art as much as it is a Science

Education of the customer is crucial to their survival

Frozen Process does not apply to wax chemistry



Our philosophy

Producing state-of-the-art casting waxes is more than just high-technology – we believe it is a science of its own.

DEKRA

MORSA certifications
Certification to ISO 9001:2008, certification and monitoring waste management facility were all completed successfully and must be renewed annually. These processes ensure quality and consistency of our products. Our main production facility, company headquarters and distribution center is situated in Krumbach (Germany).

Incoming used wax & raw material input control
The incoming wax from a foundry is specially marked and kept strictly separate so each customer receives back their own material in order to ensure exclusion of unwanted elements. Each customer receives a certificate of analysis for every batch.

MORSA
CASTING WAXES

THANK YOU

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