

The Chemical Analysis of Ash in Reclaim and Virgin Waxes

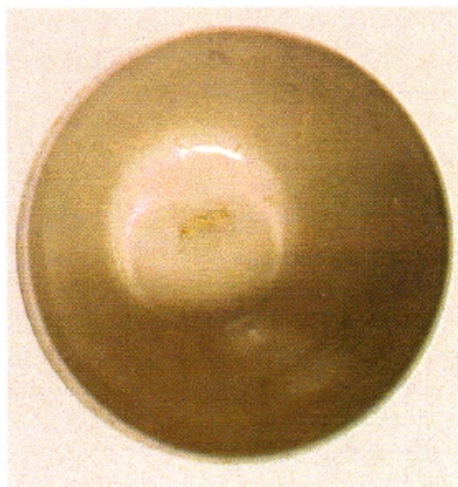
Controlling residual ash in ceramic molds after burnout is important to the investment caster and to the quality of his castings. For this reason, M. Argueso & Co., Inc. contacted an outside company to assist in a project

to identify the chemistry of ash from wax. The company was selected for its experience in working with ceramics and nonmetallic inclusions in metal, for its ability to do quantitative analysis of metallic oxides.

The investment casting industry has lived by the percent of ash of certain waxes, but what is more relevant in most cases is "what does the ash consist of?" Ash levels for virgin wax generally range from as low as 0.001% to as high as 0.015%. Some waxes may have more than 0.015%, but that is not considered the norm. Wax reclaimed by Argueso (depending on our customer's requirement) is 0.03% maximum and generally is in the range of 0.003-0.005%.

Many samples of virgin and reclaimed wax from various manufacturers were examined for this article. Some of these waxes have an ash content as high as 0.1%. The industry's common perception is that reclaim wax does not have to qualify its chemical composition to a virgin material in its ash content because it is considered a secondary product, used primarily for sprues, gates, and noncritical parts.

All waxes introduced into the ceramic shell become one major component during autoclaving and drainage. There is a potential problem if these materials are not properly cleaned during the manufacturing process. Sprue and gate wax can enter pattern wax cavities in the shell during dewax, and pollute it during wax elimination. The ash residue could react



85-- f29-69 Virgin Wax



34-- Processed "As Received"
Autoclaved Wax



21--30% Bis-A Filled Competitive



12-- "As Received" Autoclaved Wax



20-- Unprocessed Autoclaved Wax

with shell material during shell preheat or with metal during pour, forming gas and inclusions.

This article describes efforts to identify oxides present in wax ash and demonstrates how, with techniques developed over many years, Argueso has been able to reduce the ash content of the reclaim wax to virgin pattern wax levels in 90% of all cases. The procedure is patent pending with a trademark name "Tech-Clean® Reclaim."

Determining Ash Content

Several different processes are used in determining ash content of wax. It is not within the scope of this article to discuss the different methods. For this study, however the chemistry of ash after firing in porcelain, nickel and platinum crucibles was compared.

The porcelain crucibles contributed to the SiO₂ content and other ceramic oxides due to the breakdown of the glazed coating on the porcelain crucible at temperatures ranging from 1300-1800°F (705-985°C). Some oxides react with the ceramic and fuse to the crucible at these temperatures.

Nickel crucible trials still did not offer a true picture of the breakdown of residual ash because of the matrix influence from nickel oxide. Project managers finally opted for platinum, expensive but the best material due to its capability of accepting high temperatures and not reacting with most materials.

Analysis of the Ash

Ash should be considered not only as a percentage of the decomposition of wax; more important is the

makeup of the particular ash product.

Table I shows the distribution of oxides in the ash reported in milligrams (mg) per 50 grams (g) of wax ashed in a porcelain crucible. These waxes are two different virgin waxes containing 30% bisphenol A filler.

Table II shows the comparison between lots of Argueso and the same competitor wax as reported in Table I.

These waxes were ashed in new nickel crucibles. The results were corrected to cancel nickel oxide (NiO) contamination from the crucible.

Controlling Ash In Wax

Ash chemistry in new or "virgin" wax will vary from time to time because of variations in raw materials. The ash content of these raw materials is held within defined limits in order to minimize overall ash content of wax.

The heart of this project, however, is centered on the ash in reclaim wax. Wax salvaged from autoclave processing poses another problem. Ash levels up to 0.2% are encountered. Waste disposal laws and economic pressures cause foundries to reclaim wax. Simple reclamation processes involve water removal and filtration. These processes however do not remove the inorganic materials from wax. Argueso uses a proprietary patent-pending process that reduces ash and inorganic ingredients found in autoclave wax.

Table III shows the chemical analysis of an "as received" autoclave wax compared to the same wax after processing. Processing the wax reduced the ash content by 74%, which is very close to virgin wax ash levels. A side-by-side comparison of chemistry before and after reclamation shows the SiO₂, NaO, SO₂, CaO, Fe₂O₃ were significantly reduced.

Visual Appearance of Ash

The photos of ash on the opposite page show differences between virgin and reclaimed wax, unprocessed and

TABLE I
Porcelain Crucible Ash
Comparative Ash Content
mg / 50g

Sample	WAX 1	WAX A
	(30% BIS-A Filled)	(30% BIS-A Filled)
Crucible	Porcelain	Porcelain
% Ash	0.005	0.003
Ash (mg)	2.500	1.51
Na ₂ O	0.23	0.05
MgO	0.07	0.05
Al ₂ O ₃	0.58	0.08
SiO ₂	0.73	0.13
P ₂ O ₅	0.15	0.06
SO ₂	0.08	0.54
Cl	0.01	0.01
K ₂ O	0.04	0.05
CaO	0.24	0.47
TiO ₂	0.04	—
Cr ₂ O ₃	0.03	—
MnO ₂	ND	0.01
Fe ₂ O ₃	0.28	0.05
Other	0.02	—

processed autoclave wax.

Crucible X5 contains the ash from F29-69 virgin wax. F29-69 is a

30% bisphenol filled wax.

Crucible 21 shows the ash from a 30% bisphenol-filled competitor's virgin wax. Note that there is a pink tinge indicating presence of a slight amount of iron oxide. A red or pink color is a good indicator that iron oxide is present in ash.

Crucible 20 contains ash from an unprocessed autoclave wax. This is an example of copious amounts of iron oxide and high ash content. This wax is typical of a product that has been de-watered, filtered, and re-used several times by the foundry.

Crucible 12 shows the ash of the wax whose chemistry is described as "as received" in Table III.

Crucible 34 shows the ash from the fully processed "as received" customer's wax, which has been reclaimed through the patent-pending process known as "Tech-Clean® Reclaim." Note the complete absence of red and total reductions of ash.

Virgin wax may contain a relatively minor amount of ash. The re-use of foundry wax without proper reclamation continues to create a build up of larger amounts of ash that can affect casting quality.

With the identification of the chemistry of wax, ash should not be seen only as a percentage of the decomposition of wax, but more importantly, it must be examined as to the makeup of this particular ash product.

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TABLE II
Comparative Ash Content
mg / 50g (Ni Crucible)

<u>Sample</u>	<u>WAX 2</u> (BiTS-A 30% Filled)	<u>WAX B</u> (30% BIS-A 30% Filled)
Crucible	Ni	Ni
%Ash	0.005	0.004
Ash weight (mg)	2.5 mg	2.0 mg
<u>Oxide</u>		
Na ₂ O	ND	0.03
MgO	ND	0.11
Al ₂ O ₃	1.52	0.58
SiO ₂	0.50	0.42
P ₂ O ₅	ND	0.08
SO ₂	0.10	0.22
K ₂ O	0.05	0.04
CaO	0.06	0.34
MnO ₂	0.03	0.03
Fe ₂ O ₃	0.14	0.12
CuO	0.07	—
Other	0.03	0.03

TABLE IV
Autoclave Wax Processed to Remove Ash

<u>WAX</u>	<u>% ASH</u>
As received	0.026
Processed	0.0028

TABLE III
Autoclave Wax Ash Chemistry Before and After Reclamation

<u>Sample</u>	<u>As Received</u>	<u>Reclaimed</u>
Sample Size (gm)	50	0
Crucible	Platinum	Platinum
%Ash	0.026	0.0068
Ash wt (mg)	13	3.4
Chemistry:	mg/50g	mg/50g
Na ₂ O	0.45	ND
SO ₂	0.49	ND
CaO	0.66	ND
Fe ₂ O ₃	2.07	0.13
Other oxides	0.38	0.31