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MOLTEN ALUMINIUM CLEANLINESS – IMPROVING MEASUREMENTS

BY

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Abstract. The current papers try to improve the measurement on the molten aluminum regarding cleanliness. The reliable performance for this category of products can be achieved through control of inclusions inside material. The material touches some topic like improving comparability of cleanliness results and include new and old techniques used.

Keywords: inclusions; "Premetz"; liquid; improving quality.

1. Introduction

The inclusions from the aluminium alloys are most of the time quite a familiar complication in a big variety of products. For this type of products are known on the market a variety of methods for inclusion removal in the casting process, like fluxing and filtration of the molten fluid.

Unfortunately, while some methods for elimination had been already established, the methods for measuring this are a little less standardized and there are not available explicitly in the present.

Indeed, even the contains of the molten aluminium liquid whom it is measured without being standardized, for that there is a variety of techniques of

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measurements already available. Usually the measurement of cleanliness it is done for a product, or a surface, a device or for the liquid material used. That is why, this particle are solid parts who are from metal, plastic, rubber, oxides, minerals, salt and the mineral nature of low solubility even on high temperatures. Usually the paste and the glue there are not considered inclusions who produce contamination. The particles there are perturbating or the particles who didn't melt it or they didn't loosen are not considered independent particles. Only the one loosens can be investigated for an evaluation.

PoDFA (the sponges disc used on filtration for the cleanliness) it is the 1st method and the original one, initial used and developed in 1960 and it is developed on a metallographic examination of filtered residues with an estimation approximately of the inclusion content. Like already explain in the previous paper, LiMca (liquid metal cleanliness analysis) uses the principal Coulter for electronics and it is counting the number of inclusion from 1 kilogram of material in which it is seen the final result mainly using this method but considered to be fragile and expensive. The last generation of measurement equipment it is Prefil (filtration using pressure) which is searching to extend the initial technique used PoDFA through measurement of the final weight while in the same time is showing the cleanliness but without being quantifiable (Dzetzit and Nagîț, 2017).

At this moment, even something newer it is developed and that is "Premetz", who promises to be a fresh developed method and fully qualified, of the Prefil test. This could be less expensive and more robust, and it is pretending to indicate in real time the cleanliness degree.

2. Advices for Having in Consideration Regarding Cleanliness for Products

2.1. Steps before Extraction

In a standardized environmental of a manufacturing plant, the cleanliness speciation starts from the 1st producing steps until final processing step. So, this means, it is performed:

– On the initial stage once the parts are received on incoming area from the outsource components. The initial inspection can determine from the beginning if the process is stable on the manufacturing level or it is perturbed by the outgoing products.

– If the process can be considered stables, the quality checks and observation of the overall manufacturing procedures in which cleanliness has an impact: cleaning liquid, lubrification, surface treatment, soldering, assembly operations.

Usually, for all the methods presented in the first parts of the paper, the measuring method, it is not a direct one like optical, digital or contact tests. The

method of measuring cleanliness it is an indirect one, in which involves samples, not only from relevant surfaces, but also for fluids involved on the processes (Zhao and Qin, 2017). The surfaces that can have an impact on the functionality of the product have in the automotive industry a very wide domain in which they are used. This can come from pipes, tunes, tanks, pumps, air spring systems, valves, valves block or similar structures.

The PoDFA technique has been utilized for more than 50 years to measure molten cleanliness and it is use like a "golden" sample from which other techniques were developed. The problem discovered with this method it is that if the material it is very pure, the inclusion population can be supplementary, and to focus them in a filter with a small shape, will not provide a concluding accurate result (Dzetzit and Nagîț, 2017).

The cleanliness grade of the surrounding area of production needs to be sufficient to maintain the cleanliness grade of a component. The blank value represents the complete estimation of contamination from the molten aluminum that it is not specified in the requirements. Beginning of such obstructive inclusions can be: test fluids; extraction installations (soaks, bowls, pots, valves, tubes) all devices get into the contact with the liquid, handling process during production, extraction and analyses.

One of the items that needs to be taken in account it is that for a correct determination of the measurements, it is necessary that the equipment to be rechecked, to see if it has not been used for a longer period, it had been stop incorrectly or a component was changed, and particles had been transmitted inside.

2.2. Steps during Extraction

The volume of the liquid needs to be specified and considered. Usually the material it is selected and chosen with over-reliance between the component material and the expectations and requirement of the cleanliness class. One of the characteristics should be viscosity in which a value of $\nu \leq 5$ mm²/s. Among these, its need to be taken in account the history of the component and the material and the final process steps (laser ability, machining, washing, trimming, etc.). One of the examples of inclusions involved in this could be assembly oils or grease, washing liquid, glues or preservations.

One of the important steps is extracting the particles. By agitating the liquid, particles will be attracted by the interior controlled surfaces that are detached from the other areas and deliberated into the liquid. The agitation process allows the fluid to detain a force on the inclusions in different directions and avoids that "dead" areas and under zones to be outstretch correctly by the liquid (Evans *et al*., 2018).

In this way the loosen particles are kept in the movement and not reattached. Usually the set-up extraction depends on the shape, size and weight

of the liquid that we discussed. Due to movement and heat, the particles can strike against one another. Assuming all discussed, the main parameters are:

– Attributes of the molten aluminum liquid;

– Volume of the trials of liquid used;

– Period, amplitude and periodicity of the agitation during sampling;

– Number of fillers all objects encountering the component and test liquid.

Below some numeric parameters used for the test performed (Table 1).

Table 1

Parameters & Conditions

Parameters	Limits & Conditions	Real measured value
Filling volumes	30% to 40%	33%
Amplitude	Approximately 30 cm	Measured: 29 cm
Frequency	1 Hza	1 Hza
Time	15 s	17 s

The filling masses that is specified between 30% and 40% would not affect in the end because a too low or a low high filling quantity does not involve sufficient mechanical energy to generate a satisfying cleaning effect (ISO 11500:2008).

The last step that needs to be taken in account it is to transfer all the molten aluminum for filtration and analyses and fill out the verifying report.

3. Test Performed, Analyse and Error

All the measurement using Prefil or PoDFA use the same technique for this type of process. When the liquid passes through the filter, the weight/ time/ frequency curve result should be a straight line, an inclination that is defined by the filter permeability. Usually filters functions is to keep only the particles that you need to analyse. The pore proportion it is chosen taken into consideration the cleanliness requirement of the material. To make sure that the elongated particles are detected, the following rules usually applies: filer pore size: 1/10 to 1/5 in relevance with the smallest particle determined, 1st one for inclusions more than $\geq 50\mu m$ and the 2nd one $\leq 50\mu m$.

In the history of the measurement material, the curve of the weight versus time was the metrical from where conclusions can be estimated.

A prefill test which naturally represents a straight line will not have any contribution from the flow rate: the consistency it is determined.

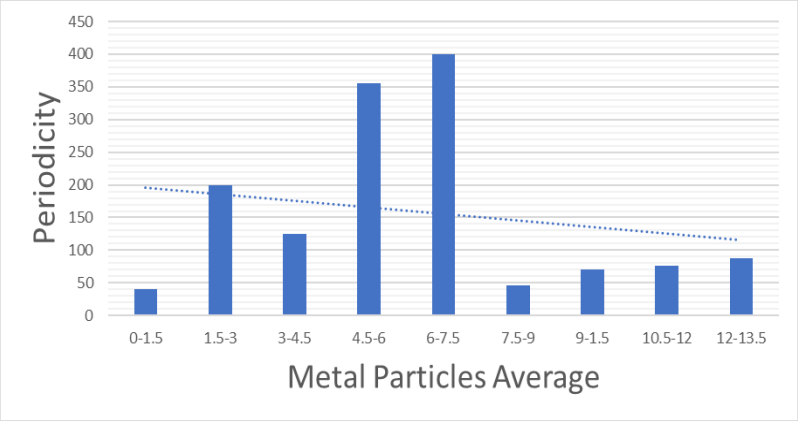

Fig. 1 – Distribution of particles on a 3 day working process (12 samples).

In the small range the proportion of 0-1.5 means that the metal is quite clean, and the quality of the material is good. Also, the material with inclusion and untreated metal with have values in 40 or bigger, like in Fig. 1 (VDA Volume 19, 2015). After the values had been extracted, the analyse and the raw data can be used to calculate the standard error with the model fixing parameters, specifically for the values determined, using that tests.

Nevertheless, like in the current graph, if usually the line is declining, it means that is untied at an invariable rate and no farther investigation is recommended, the method can be confirmed and followed.

If the line it is more looking like a picked curve, it means that it is delayed dissolving the contaminated particles or the material it is not clean sufficient (ISO 11500:2008).

In case the line it is constant, several reasons can be investigated:

– Chemical impact or mechanical influence is having such an influencing effect that they are not put into adhering contaminated, but they are providing originally instead of the material instead.

– If you have very clean material, a method that can be used to definitely differentiate between the particle charge requiring distinguishing between the particle charge requiring detection and the "blank" standard level of co efficiency in the run tests.

– A different reason of a constant trend can be residual magnetism in the case of the ferromagnetic components or inclusion that can determine magnetism inside material.

Liquid contamination is undesirable media that affects fit, form, function, performance, appearance of components, assemblies or products.

For non - safety relevant parts (populated PCBs or products), the following escalation scenario (Fig. 2) shall be applied.

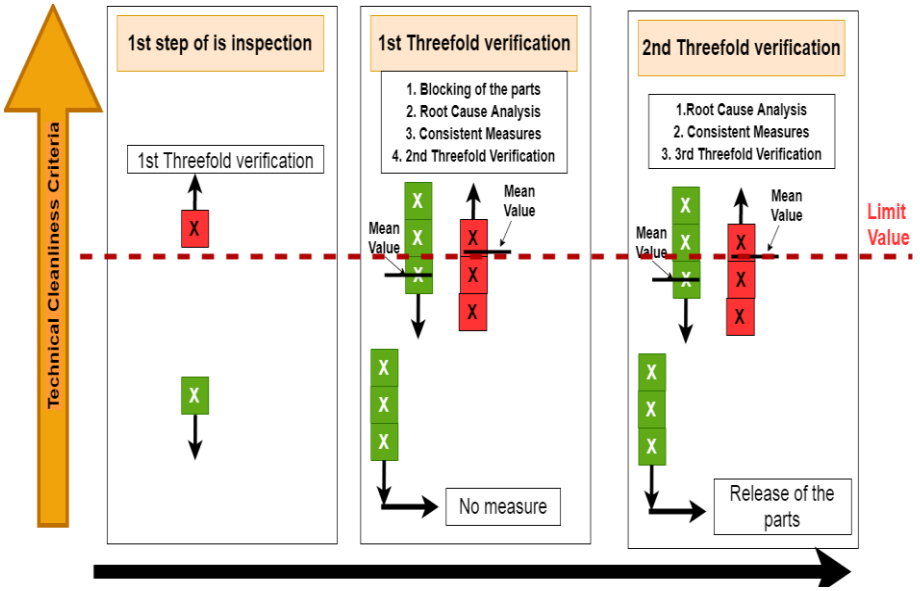

Fig. 2 – Reaction plan.

4. Conclusions

It can be concluded that there had been improved the methods for measuring the inclusion into the molten aluminum. The advices given for the methods, more exactly for the "Premetz" or even for any other will improve the results in a positive way. Like described, this means improving the sampling of the molten aluminium. LiMca it is of course the older one and the most used one even that cannot recognize all size and types of particles, like PoDFa. So, the improvements brought by the research, the cleanliness degree and status determined by Premetz it is with 50% more, faster and quicker. For sure, now there is no achievement of outstanding high-quality output, eliminating at all but they are developed more and more methods and solutions.

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GRADUL DE CURĂȚENIE AL ALUMINIULUI LICHID – ÎMBUNĂTĂȚIREA MĂSURĂTORILOR

(Rezumat)

Lucrarea prezintă rezultatele obţinute la măsurarea gradului de curăţenie a aluminiului obţinut prin topire, ca urmare a îmbunătăţirii metodei de măsurare. Pentru creşterea performanţelor acestei categorii de produse, utilizate în industria de automotive, se urmăreşte reducerea incluziunilor din materialul topit. Ca urmare, în lucrare se prezintă o nouă metodă "Premetz" bazată pe diverse îmbunătăţiri aduse metodei de prelevare, a interpretării rezultatelor prin compararea acestora şi astfel eliminându-se cauza. Se constată că prin utilizarea metodei propuse, gradul de contaminare a materialului scade cu 30%, evaluându-se pe posibilitatea analizei a materialului inclusiunilor, numărul inclusiunilor.