PRODUCT IMPROVEMENTS/PROCESS IN THE USE ALLOYED OF ZAMAC

Osvaldo Junior Alves Soares, osvaldo148@itelefonica.com.br
Universidade de Taubaté – Street Daniel Danel, 210 – Taubaté – SP - Brazil

Álvaro Azevedo Cardoso, PhD, azevedo@unitau.br
Universidade de Taubaté – Street Daniel Danel, 210 – Taubaté – SP - Brazil

Dr. Carlos Alberto Chaves, carlosachaves@yahoo.com.br
Universidade de Taubaté – Street Daniel Danel, 210 – Taubaté – SP - Brazil

Abstract. *This scientific article aims to solve a problem of fundamental importance which is the high costs and to improve the weight of the products that before were only manufactured by conventional processes that used steel carbon materials. So the proposal is to use a lighter and a cheaper material, it means the Zinc alloyed named Zamac. And I will be explained the advantages and benefits of Zamac, of which we can notice the optimization of a very interesting manufacturing process. For the elaboration of this article it was necessary some inquiries for the attainment of data to justify the advantages of the use of Zamac instead of using the Carbon-Steel. Therefore, it was made a step by step evaluation of the Advantages and Disadvantages until the attainment of the results. We have some of the item taken into consideration for evaluation as it follows: It was evaluated: the cost of the raw materials of the Carbon-Steel and the Zinc alloyed, specific weight, processing easiness and presents low maintenance. After all these analyzes we submit the manufactured parts with Zamac to the same requested tests in carbon-steel parts and got good performance. It may be concluded that the application of the Zinc alloyed named Zamac, presents great advantages on the use of materials and conventional processes as of steel carbon, being therefore an excellent alternative in the replacement of other materials guaranteeing good performance and low cost.*

Keywords*: Zamac, Cost, Performance.*

Justification

The elaboration and development of such a scientific work is justified by the fact that we do believe to have an option of an innovative process using Zinc alloys**,** which can fulfill the conventional materials (carbon steel) requests as a whole. Using this process of casting to manufacture products that nowadays are only produced with carbon steel, we will find a comprehensive response to any tests and operation.

Introduction

The processes of production of light alloys have been expanding more and more in the industrial segment. Therefore, in this article my aim is exactly to study on the difficulty in processing parts manufactured in processes involving conventional carbon steel materials to the usage of processes involving materials of Zamac alloys that have been achieving the trust of the parts and products market.

A elaboration the new alloys planned for gravity casting named ZA-8 (with the aluminum content varying between 8,2 and 8,8 %), ZA-12 (with the aluminum content varying between 10,8 and 11,5 %), ZA-27 (with the aluminum content varying between 25,5 and 28,0 %).

The crucial factor to the great stability of the mechanical and dimensional characteristics of the parts casted under pressure in zinc alloys is the pureness of the alloy's elements. The zinc used in the alloy preparation is the SHG type - Special High Grade - with the minimum content of 99,999% (BS EN 1179: 1996).

The Zamac is a Zinc alloy formed by: Zinc, Aluminum, Magnesium and Copper, and the name Zamac is accompanied by several kinds, and with several bands of chemical constitution

Acording the Shivpuri, (1995) The alloy of Zamac is industrially used in processes of casting due to its particular peculiarities. In Brazil, about 3000 tons of Zinc alloys are produced every month. Speaking a little bit more about this Zinc alloy, we notice that it is a material of low point of fusion, that presents high mechanical resistance and good qualities of casting according Alloyed, (200) beyond others, what enables the attainment of complex format parts, with excellent superficial finishing, likely to undergo painting processes and superficial finishing without any problems and still keeping a good performance.

According the Yoshida, (1995) Nowadays, its application through injection processes makes the production of parts something very simple, besides it offers little strain to the injection mold.

There are many specifications regulated reporting on the Zinc alloy where is generally mentioned the 4% aluminum percentage a combination of other elements: Magnesium and Copper that are added to give to a good mechanical property, coalition and good stability.

A decisive factor is the control of the chemical constitution, where its elements must be rigorously controlled so that it can give and keep good dimensional performance of the parts manufactured in this process, and another important factor is that the chemical constitution must be strictly controlled to avoid intergranular corrosion as it could damage its previously mentioned properties. According to Sartori, (2004) : Resistance to corrosion: the Zinc alloys have high resistance to corrosion, the Zinc alloys darken in contact with the atmosphere but it does not have any harmful effect unless you want any decorative effect.

Discussing about a Zinc alloy according the Dorch, (1991) we cannot forget that there are impurities which can be intrinsic, in other words which can be part of the manufacturing process to obtain the Zamac.

Such impurities are: Lead, Cadmium and Tin. These are the impurities incorporated in the Aluminum alloy.

And, what can these impurities generate?

Being above the specified, such impurities origin the intergranular corrosion, what can reduce the performance and durability of obtained products. in this in case, the intergranular corrosion starts on the surface of the casting part, penetrating deeper and deeper as time goes by and follows the contours of the grains, until all part is corroded.

More specifically speaking about the intergranular corrosion, it occurs due to the way the alloy is produced.

The chemical elements existing in the alloy can accelerate or delay the intergranular corrosion; for example, if we have an excessive percentage of Copper and Zinc those two elements will be basically responsible for the intergranular corrosion contained in the products manufactured by Aluminum alloys.

Applications

We can point out several routine applications such as:

The Automobile industry that applies the Zinc alloys to manufacture door handles, radiators, lantern plates, rear-view mirrors, locks, bomb-bodies, tank covers, gears and windscreen cleaners, among others.

In the electronic household industry, it has been used in blender bodies, mixers, vacuum cleaners, fans, safety nets for radio and television sets, clock components, etc.

In the Civil Engineering and Aviation today, approximately 70% of the materials employed in the structural airplane components are made of Zinc alloys; in this particular case it has been used the alloys of the 2XXX and 7XXX series that are technical specifications, in other words, rules relating to the Zinc alloys. This series receives a thermal treatment by precipitation and must be emphasized for its massive application in aircraft industry. This series of materials of these two specifications offers good resistance to fatigue and good tenacity against breaking.

Those two series of technical specifications are applicable to the following aircraft components: fuselage covering, machining and conformed wings and caves, frame rails, ribbings, several steel framing, reinforcing bars, etc. Thus, the study of the alloy AL 7475 - T7357, widely applied in aircraft's production projects, became more discussed, aiming at knowing better its characteristics and behavior under different aspects which are important to the alloys development to aeronautical application.

A little about the Aluminum history

According to a research at the Phisical and Chemical Properties (2006), Physics and Chemical domains in a decreasing order, according to its weight, the elements that compose the Earth crust, Aluminum takes the third place, representing eight per cent in its total weight. This metal takes part of a great amount of rocks and precious stones; among the first ones, we can mention their mineral and metallurgic interests, the feldspar, the micas, the tourrmaline, the bauxite and cryolite. Among the precious stones, the ones which represent the higher Aluminum content are corundum, the sapphires and the rubies.

The aluminum has high levels of electrical wire, and it does not change when there is an air contact or water contact due to a fine tiered of oxide that protects it from the environment attacks. Therefore, there is a high reactivation when in contact with other elements, for example, in contact with oxygen, it suffers a combustion, discharging a great amount of heat, and matching with alogenios (Chlorine, Flúor, brome and iodine) or with brimstone, immediately causes the respective haletos and aluminum sulphates.

Discovery and Alluminium applications

Long ago, we had already known the existence in the alumen (double metal sulphates) and other minerals, an specific metal characteristic. However, only in 1825, isolated the aluminum, through, aluminum chlorine reduction in a potass malgama. Later, other chemists performed several experiences that allowed a more accurate studying about this metal properties.

Alloyed Aluminum, (2006) had some works emphasizing after achieving clear powder and globules of aluminum.

A modern Aluminum production started in 1886, due to simultaneous efforts of a French called with the developed process, almost at the same time. This procedure is supported by the use of electrical energy, consisted in submit alumina dough (Aluminum oxide) purified, solved in fused cryolite to the electrolysis process (substances decomposed in a solution through an electrical metal chain way).

It is in the high level industrialized countries that exists the greatest Aluminum application options. The greatest part of the world's production devotes to automobile and aeronautic industries.

Another important application of the Aluminum is the production of the wire, not only using the clear metal but alloys too. We can produce electrical transmission cables of Aluminum, through wiredrawing. In means of security these wires are often recovered with a flexible isolating crust, usually made of rubber. It is used, due to its great electrical and thermal wires to electric technical, condensers and reflectors.

The aluminum alloys, presents important proprieties, mainly concerning its manipulation easiness and plastic deformation. As a result, they are extensive engaged in the screw, bolter, pins, hings, etc. These characteristics delimitate the big aluminum application fields and its alloys, the building material. This way, it is usual the use of this material in façades and at windows production. The aluminum is utilized for its air resistance and some often erosion in leaves and plaques, several packages, several covers to serve chemical industries, chemists and the nutririve one.

The Under Pressure Fusion

The under pression fusion process, according to Malavazi (2005) belongs to the group of process which uses continuous castings. Other group members include the coquilhas fusion to gravity and low pressure injection process.

Archaeological evidences suggest that the coquilha's fusion process were used in the bronze ages for manufacture guns, using stone castings.

It is not known the origin of the under pressure fusion process but, people considered that its presence is connected to the production of lead alloys for the typography in the second part of the nineteenth century.

The manufacture of the first hot injection chamber to be operated with condensed air in 1907 being used in large scale for the production of gas masks and components for binocular during the First World War The zinc was the metal until now, the most used when in 1929, developed the Zamac alloys.

The use of the aluminum happened for the first time in 1914, using a injected machine where the metal was introduced in the casting cavity with the aid of condensed air. The equipment used was similar to the hot chamber that was unsuitable due to the great aluminum reaction with the machine's components iron. In 1930 appeared the first icy chamber machine that allowed to reduce the time of liquid metal contact with the machine components.

Many others developments happened since the 30s decade:

- The use of the process for the injection of copper alloys;
- Development of the high clear alloys;
- The automatiction of the injection machines;
- The enlargement of the machines size and injection ability;
- Optimization from the means of process control;
- Development of the sulphur oxide for the protection of the magnesy alloys, facilitating the use of this metal in the injection process.

Intensive researching programs became even more effective and competitive widen the scale of injected products attending nowadays, several economy sectors. The fusion process was not an art anymore where the results were gained through intensive tries to become accurate Science.

The injection aluminum machines feed considerably in the last twenty years, due to the advance of the automobile industry requiring products that allow to increase their automobiles performance (through weight reduction and resistance where effectively garantee the quality of the injected one).

The under pressure fusion process is the most expensive one competing with the printed process, shape with a hammer and injected pieces in plastic where is required a great capacity of production and excellent repetition.

The typical pieces produced by this process attend several industrial sections

The advantages of the use of the process in Zamac alloys:

- Allows the gain of complex pieces;
- Eliminates a high cost procedure which is the machining;
- High production capability;
- Some or no machining;
- The production of pieces from fine walls;
- High durability pieces production, accuracy and that allow excellent superficial finishing;

- Allows the gain of pieces with texture;
- Can be submitted to superficial treatments with excellent results.

The description of the under pressure injection process by Malavazi (2005)

The process consists in injecting liquid metal (Zinc, Aluminum or magnesium alloys) contained in a recipient (injection chamber) in the internal of a casting cavity produced in steel.

Different from the conventional process to gravity, the injected metal is submitted to high pressures (beyond 100kg/cm2) obligating to fill re-entrances and details that in others process would be impossible.

Basically there are two under pressure fusion process, the most used are 'the hot chamber' and 'the cold chamber'

According to an article from Jefferson Malavazi, the injection chamber is found in the oven, immersed in liquid metal.

The equipment consists in a maintenance oven heated by electrical resistances forming just a injector unity. The conduction of the liquid metal in the casting occur through the advance of the injection piston inside the pressure chamber.

This kind of equipment is used for the injection of alloy zinc, tin and lead pieces, once do not cause a high erosion of the pressure chamber happened when aluminum is used. The specific injection pressure does not exceed 300kg/cm2.

Processes of Horizontal Cold Chamber

The injection chamber is made use horizontally and connected the machine is one of the used systems of injection more world-wide and that it has suffered constant improvements for bigger control from injection process. The feeding of the liquid metal is made by an orifice in the injection chamber and the piston of injection, connected to the top of the chamber, leads the metal to the long one of this until the socket of the mold.

Objective of the Work

It is had as objective in this scientific article to together study the conditions of manufacture and use of the steel folloied carbon of the process of machining and zamac with its benefits.

Methodology:

It was step by step made an evaluation of advantages and disadvantages until arriving in the attainment of the results, then below it follows some of itens evaluated.

1º. Evaluated substance cost cousin of the steel carbon together with the operation of machining and of the leagues of Zamac.

2º. We identify that Liga de Zinco has weight specifies minor of whom the steel carbon.

3º. The processing is easy.

4º. It is obtained to more than get a part for operation cycle.

5º. Speed of process in the attainment of products with bigger amount is had.

6º. The materials for confection of the molds are of easy acquisition.

7º. The process presents low maintenance. Comparative table of weight I specify of zamac and the steel carbon (tab.01).

Table 01. Comparative table on weight I specify of the materials Zamac and Steel

Specific weight of the Zamac	Specific Weight of Steel
6,5	7,86

They perceive that only for these comparative degrees we have a considerable reduction of weight where we can count on 17,31 % of reduction in weight, what it is sufficiently considerable for the process.

The factor that is more attractive of all is the costs where we can relate the price of the steel together carbon with the operation of machining collating with the process of injection of the Zamac.

For the processing of terminals layer for example that it is a product usually used in the automobile industry where its manufacture stops initiates for a bar in steel carbon and is had that to add in the a operation of machining so that let

us have the total ready part without counting that still it is necessary terms that to add in the part a superficial treatment so that it can protect from weather hazard and with this not to leave with that the part is oxidated by weather hazard.

The superficial finishing has as objective to all protect the part in the cycle of its process until arriving in the final destination that is I propagate it mounted. (tab.02).

Table 02. See prices comparative of costs.

		USINADO		ZAMAC					
Assembly	**Component**	**Weight (kg)**	**Cost (R$/pç)**	**HL**	**RM**	**Cust (R$/pç)**	**Reduction**	**Annual Volume**	**Annual Reduction**
037.54.0695	200.11.0278	0,0132498	0,475682	0,027325	0,065444	0,092769	0,382913	28800	11027,8808
037.54.2451	200.11.0278	0,0132498	0,475682	0,027325	0,065444	0,092769	0,382913	432000	165418,212
037.54.2439	200.11.0278	0,0132498	0,475682	0,027325	0,065444	0,092769	0,382913	79200	30326,6722
37.54.07	200.11.0278	0,0132498	0,475682	0,027325	0,065444	0,092769	0,382913	72000	27569,702
037.54.2440	200.11.0278	0,0132498	0,475682	0,027325	0,065444	0,092769	0,382913	3600	1378,4851

HL = Hand Labor
MP = Raw Material

Productive amount citing some components is showed in tab.03.

Table 03: Production per hour

TERMINAL Parts	**PRODUCTION PER HOUR**
200.11.0278.00	1600
200.13.0809.00	1600
200.11.0279.00	1600
200.13.0670.00	1600

After all these you analyze we submit the parts manufactured in the process using physical leagues of Zamac to the durability tests and tests, for ends to compare Performance of the two types of materials.

Results

As results we have a considerable reduction of cost arriving to reach 80,49 % of reduction cost of the part, as related table 1 in the methodology.

Other significant reduction is in the weight of the part where we can notice the reduction of 17,31 %, as related table 2 in the methodology.

These reductions of fact still more attracted and inclined for the use of the process using leagues of Zamac.

To evaluate the substitution of manufactured products of steel materials carbon with operations of machining for products manufactured with materials of leagues of zamac, a survey in a company was made who manufactured some of its components in steel carbon to be used in diverse mounted sets of handles of command for supply the automobile industry. Being that in this survey we verify that in the manufacture of terminals of command handles as, for example: handles of accelerator, handles of brake and handles of clutch would have so good performance how much of conventional use manufactured with steel materials carbon, as much in the question of costs how much in the question durability and processes of manufacture in this process. Already in the question durability tests had been diverse facts as, for example, resistance assays the traction, that has for objective to evaluate the resistance mechanics of the part in question simulating the real use at the moment of request of the function of propagates it and the products manufactured with materials of aluminum alloys had had excellent performance in its performance reaching many times indices until little bigger.

Discussion

According to the text of scientific analyzes by According the Shivpuri, (1995) The alloy of Zamac is industrially used in processes of casting due to its particular peculiarities. In Brazil, about 3000 tons of Zinc alloys are produced every month. Speaking a little bit more about this Zinc alloy, we notice that it is a material of low point of fusion,

that presents high mechanical resistance and good qualities of casting according Alloyed, beyond others, what enables the attainment of complex format parts, with excellent superficial finishing, likely to undergo painting processes and superficial finishing without any problems and still keeping a good performance, being thus of my point of view I agree to its theories and I more ahead go in view of that today we have vast varieties of types of parts in the automotive area, household-electric, aeronautical and even though in the industry of civil construction being that with these principles of production series today in it benefits for the production of the pursuing above mentioned.

Conclusion

We conclude that the effective use of the Zamac alloys represents great advantages to the use of materials and conventional processes as Steel Carbon being, therefore, an excellent alternative in substitution to other materials guaranteed by this steady good performance and low cost.

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References

Alloyed Aluminium, 2006, " Properties and Characteristics about the Aluminium" Company that to Manufacture Production Using the Alloyed Aluminium, 15 nov. 2006, http://www.abal.org.br/aluminio/ligas.asp.

Alloyed Aluminium, 2006, "Especification the Alloyed Aluminium to Fundiction", Aluminium to use in Process the Fundiction, 16 Nov. 2006 http://www.diecasting.org/dce.

BS EN 1179: 1996. "Brith Standard - Zinc and Zinc Alloy Primary" Zinc, Designations, Marking, and Color Codes.

Dorch, .C.R., 1991 "Congress of NADCA, Detroit USA Evaluating the Heat Treatment of Premium Quality Die Casting Die Components".

Mallavazi, J. 2005 "Processes of Casting under Pressure". Aluminium Metalurgy and Alloyed Aluminium to Aplicatiom in Fundiction Process, 9a.ed. jan 2005.

Phisical and Chemical Properties the Alloyed of Zinc, 2006 " Resistence and Performance using the Alloyed Zinc and Chemical Properties the Alloyed Zinc http:// www.tabelaperiodica.com.br, 25 oct. 2006.

Sartori, C.H., and Andrade, C.M., 2004 "Oxy Process", Thesis A New Superficial Treatment for Tools of Function of Aluminium, São Paulo, SP.

Shivpuri, M.Y.U., and Rapp, R.A., 1995 "Effects of molten Aluminium", on H13 Die and Coatings., Journal of Materials Engineering and Performance.

Yoshida, S.O., and Vendramim, C., 1995 "Increase of the Useful life in Matrices of Forging to the Hot one", XV National Seminary of Forging, Porto Alegre, RS.