International Journal of Engineering and Management Research e-ISSN: 2250-0758 | p-ISSN: 2394-6962
Volume-11, Issue-2 (April 2021)
www.ijemr.net https://doi.org/10.31033/ijemr.11.2.2

Classification of Metals used in the Sand Casting Process

A. Arun[1], R. BalaKrishnan[2], R. Jayanthi[3], H M S. Kevin[4], A. Ranjith Raj[5], S. Paramaguru[6], R. Kumar[7], M. Ganesan[8], R. Rekha[9]

[1]Student, Department of Mechanical Engineering, Saranathan College of Engineering, Anna University, Tiruchirappalli, Tamil Nadu, INDIA

[2]Student, Department of Mechanical Engineering, Saranathan College of Engineering, Anna University, Tiruchirappalli, Tamil Nadu, INDIA

[3]Student, Department of Mechanical Engineering, Saranathan College of Engineering, Anna University, Tiruchirappalli, Tamil Nadu, INDIA

[4]Student, Department of Mechanical Engineering, Saranathan College of Engineering, Anna University, Tiruchirappalli, Tamil Nadu, INDIA

[5]Professor, Department of Mechanical Engineering, Saranathan College of Engineering, Anna University, Tiruchirappalli, Tamil Nadu, INDIA

[6]Professor, Department of Mechanical Engineering, Saranathan College of Engineering, Anna University, Tiruchirappalli, Tamil Nadu, INDIA

[7]Professor, Department of Mechanical Engineering, Saranathan College of Engineering, Anna University, Tiruchirappalli, Tamil Nadu, INDIA

[8]Professor, Department of Mechanical Engineering, Saranathan College of Engineering, Anna University, Tiruchirappalli, Tamil Nadu, INDIA

[9]Professor, Department of Mechanical Engineering, Saranathan College of Engineering, Anna University, Tiruchirappalli, Tamil Nadu, INDIA

[4]Corresponding Author: hmskevin10@gmail.com

ABSTRACT

The Sand Casting Process And The Different Methods Used To Cast The Metals Are The Subjects Of This Paper. Casting Is A Manufacturing Process For Creating Complex Material Shapes. A Large Classification Is Needed To Understand The Metals Used By Researches, Why They Were Used, And What The Most Commonly Used Metal For Their Research Is. We Studied And Understanded The Various Types Of Sand Casting Processes Used By The Researchers In This Review Paper. And We Categorized And Graded All The Papers We Reviewed And Classified Based On Their Respective Study Areas And Material Use.

***Keywords*--** Sand Casting, Casting Software, Metals

I. INTRODUCTION

Sand Casting is one of the best casting process due to its inherent advantages' of no size and shape constraint. But still now it faces many issues like energy efficiency, quality control ,low production, slow cooling and more material usage. There are more methods and techniques are used in doing sand casting process. There are more journals and review paper are done in sand casting process .It is not possible to study all the papers and journals ,so a wide classification is essential for simplification and characterization. In this review paper we are going to see the classification of sand casting based on the material taken and why they are taken.

II. ALUMINIUM

C M Choudhari (2013) The process parameters and their optimum values, simulation of solidification process of materials were identified. The different types of properties are given to the material for this procedure. Aluminum castings improve automotive fuel efficiency by contributing to weight saving requirements. It is soft and malleable.

T. R Vijayaram (2006**)** In this journal the authors used many metal like Aluminium, Copper, Steel, Iron. These metals are used in the valve castings, they used these metals because they improves yields, and reduces fettling costs. They are used because they can withstand critical high pressure.

Shamsuddin Sulaiman, (1997) Network Analysis method based on the Fortran Language is used in their experiment. The metal they choose is Aluminium LM24. From the author perspective they used this metal because they can be recycled, they can hold the pressure of 100Mpa and they have high affinity onwards the Iron. They have high corrosion resistance and they are used in the marine atmospheres.

III. ALUMINIUM ALLOY

Muhammad HuzaifaRaza (2020) used is Aluminium Alloy 6063-T5.In the casting process they are very effective to examine the bottom and top gating configuration on mechanical properties. And this metal have enough viscosity to avoid any choke in the moldcavities. This metal is used in the pipe, furniture , and transportation.

J Jensin Joshua (2020) used Aluminium Alloy 7075 to attain the sand cadting with high strength, light weight and it is highly polished. Then the author added TiO2 (Titanium Dioxide) in order to increase the wear resistance and hardness of aluminium alloy 7075 further.
Zhen Xu (2020) In this experiment the author used Aluminium Alloy 6061 for his experimental studies. And the author chose this metal because of Medium-High Strength, good corrosion resistance, magnificent welding ability, plasticity and provides outstanding properties after the heat treatment process. This metal is used in a firearms manufacturing and is even in hand glider frames.

Vishal N.Kaila (2020) chose Aluminium Silicate for the experiment. He chose this metal because they posses high strength in their properties and they provide stable performance against the thermal expansion.

Swapnil Agrahari (2020) have chosen Al1230 alloy in this paper because this alloy is a wrought alloy and has high corrosion resistance. Also it is easy for fabrication, high finishing and has uniform nature after the experiment is completed.

R. P. Barot (2020) identified that AlSiCu3 alloy has high thermal conductivity, good wear resistant and high machinability. The author also observed that the combination of Silicon and copper provides high strength. So he have chosen AlSiCu3 for this casting simulation.

M. S. Ayar (2020) have used AlSiCu3 alloy because of its high thermal conductivity. Also, Silicon and Copper combination produces high strength and it exhibits good corrosion resistant. It is also easy for machining. So this alloy is used here.

M.Venkata Ramana (2020) chose Al-Si Alloy for the experiment. Author chose this material for the heat absorption capacity of reclaimed sand mould is slightly lower and resulted in slightly coarse grains of alloy that got solidified in a mould prepared from reclaimed sand.

Swapnil Agrahari (2020) For the slow cooling and rapid cooling in a sand casting process by investigating the microstructural and mechanical assets of Al 1230 alloy. The process of rapid and slow cooling alters the heterogeneities of the Al melt which modifies the microstructure and mechanical properties of the Al 1230 alloy. Al 1230 alloy is a wrought alloy with good corrosion resistance.

H.Husain (2020) 6061 Aluminium alloy has ability to resist high corrosion and withstand high stress. 6061 is a common grade which are widely used across the world. It is one of the most commonly used grades. Its alloying elements are magnesium (1.0%) and silicon(0.6%) make this grade more versatile. So the author chosen this alloy.

Ganesh P.Borikar (2019) In this Journal author used Al-Alloy LM6 and LM25 for his experiment. He chose this metal because he found minimum cavity wall gap can be found in this metal. It is a excellent resistance to corrosion in marine environments and possesses excellent ductility.

P. Rod Rodriguez Gonzalez (2019) have selected Al9Si3Cu3ZnFe alloy aluminium is very less weight, high electrical and thermal conductivity, easy for machining and also corrosion resistant. Silicon is used with aluminium due to their high strength-to-weight ratio, excellent castability, corrosion resistance and high thermal conductivity and copper is used for it's high heat conductivity, good machinability and it is a good corrosion resistant. Zinc is highly ductile when it is heated. And Iron is a ductile and malleable in nature. On the other hand the author have used additive manufacturing technology to do this experiment to save on material waste and energy also prototyping costs much less

David Weissused (2017) Aluminium Alloy for his research because of its availability and they are most popular material for the research studies.

Hodbe G. A (2017) Selected LM25 for this simulation due to its high strength when it is heat treated and it has good machinability and it is an excellent corrosion resistant and also it has high weldability.

SumaiyaShahria (2017) Aluminium 356 alloy has alloys of Aluminium, Silion, magnesium with some amount of iron and zinc. This alloy makes the material much harder and having higher elongation .Also due to its higher ductility the author have chosen this alloy.

A.M.Lovatt (2016) Aluminium has high resilient power which means it can be able to withstand in tough conditions. Several applications are occupied by aluminium alloys because of its high weight to strength ratio. It has specific gravity of 2.7g/cubic centimetre which makes the aluminium alloys a light weight metal ,enables the cost to decrease for manufacturer. Hence author used this unique property material.

Olawale Olarewaju Ajibola (2015) 6061 is a common grade which are widely used across the world.It is one of the most commonly used grades. Aluminium 6061 is the best choice in the various applications like boats, plates, instruments and in the structural applications. Its alloying elements are magnesium(1.0%) and silicon(0.6%) make this grade more versatile. Due to its ability to resisting high corrosion, stress and cracking, the author used this material.

M. Stefanescu (2015) used Aluminium alloys for the experiment because of its good electrical and heat conductivity. So in most power lines Aluminium plays a major role that has good conducting ability which makes the alloy a unique one. In so many applications it has been used as heat sink that the aluminium alloy takes the heat produced in the process very rapidly.

C. M. Choudhari (2014) have used LM6 for this simulation because it is suitable for sand casting. It is corrosion resistant and has greater strength and highly ductile in nature. As it has many benefits, the author have chosen LM6 for this experiment.

C. M. Choudhari (2014) simulated and compared the results of the LM 6 aluminium alloy by

using AutoCAST–X software. This material has been used for casting material. Its strength falls off rapidly at high temperatures and elastic limit is low.

R.S. Taufik (2013) Depending on the thermal expansion of the fibres was the thermal expansion behaviour of the aluminium silicon carbide fibre reinforced composite, and by the onset of residual stress state and interfacial strength were influenced. The material is fully dense, without voids, and is hermetic. Its high stiffness and low density suits larger parts with thin walls such as fins for heat dissipation.

C M Choudhari (2013) The casting simulation helps in identifying the location of defect in casting and the material has been proposed. LM27 alloy retains a high proportion of its original room temperature strength at moderately elevated temperatures. LM27 is a very versatile alloy and, with its excellent castability, it is suitable for most general purpose castings.

Yuichi Motoyama (2012) They were used different types of sand molds and compared their results. The different types of sand molds named as Green sand and Furan sand. But the castings were made by the aluminium alloy. Chemical composition of AD12.1 (A383.1) aluminum alloy (Cu - 1.609 % Si - 11.121 % Mg - 0.216 %Fe - 0.812 %Mn - 0.146 % Zn - 0.408 % Ni - 0.036 % Sn - 0.006 % Al – 85.646 %). The main thing is in the cooling time, there is a mechanical interaction between the sand mold and casting.

S.Santhi (2012) preferred Aluminium Alloy to withstand higher temperature for this experiment. In addition to that, aluminium alloy is cheaper than other materials, it is very light weight and it is high weight to strength ratio.

S. N. Kulkarni (2011) AlCu alloy is withstanding greater strength and the casting is very less in weight and also the solidification time is low because of the copper. This is the main purpose of choosing the alloying of Aluminum and copper by the author.

A.A. Canale (2010) selected Al-Si alloy because it has high strength to weight ratio, low density, low coefficient of thermal expansion, high resistant to wear .Also analysed that Silicon has high fluidity and low shrinkage, which results easy to cast and good weldability.

G.S.Cekkini (2008) In this journal author used A356 and A357 Alloy. These materials are casted and cooled in their material. They choose these materials because they posses high performance in the chill temperature and the metal head are high. These materials perform high function in the chill temperature and the metal head are high. They are high corrosion resistance and they are used in the manufacturing of impellers, housings, pumps valve components and tools.

S.M. Liang (2007) used Mg-Al-Ca alloy because it is excellent creep resistant. Magnesium has perfect castability, has high strength and ductile. In addition to that, it is good salt spray corrosion resistant. Calcium is very light in weight and it is so cheap. Then, Aluminium is a good corrosion resistant, high electric and thermal conductivity and it is more ductile. So this alloy is selected for thermal analysis.

S.G. Shabestari (2005**)** In this experiment the author chose 319 Aluminium Alloy (Al-Si-Cu) .He chose this material because of its excellent casting characteristics and mechanical properties.

A.Meneghini (2005) mentioned that A356 aluminum casting alloy is a 7% Si, 0.3% Mg alloy with 0.2% Fe and 0.10% Zn and the reason for choosing A356 aluminum casting alloy is, it has very good casting and machining characteristics.

Mirbagheri (2004) used AlSi alloy for this simulation because exhibit high strength to weight ratio, high resistant to wear, low density, coefficient of thermal expansion is very low .Also analysed that Silicon has high fluidity and low shrinkage, whick results easy to cast and good weldabiltiy.

Y.W.Lee (1990) They found the feeding behaviour of Al-4.5Cu, because of the smaller inter dendritic spaces the porosity content decreased with increasing solidification rate and thermal gradient. After this Al-7Si-0.3Mg alloy derived the new parameter that integrates thermal gradient, solidification time, and solidus velocity.

JarmoTamminen (1988) chose Aluminium Silicon alloy because it has high resistance to wear, low coefficient of thermal expansion, low density and also high strength to weight ratio. Then, silicon is low shrinkage material, easy for casting, excellent weldability and has high fluidity. So the author preferred Al-Si alloy as best material.

IV. ALUMINIUM AND COPPER

Thomas Greb (2020) have preferred aluminium and copper because aluminium is light in weight, corrosion resistant, it has good electrical and thermal conductivity, reflectivity and al so it is ductile in nature and the author have chosen copper for its excellent heat conductivity as well as electrical conductivity, good corrosion resistance and good machinability. So the author made Al and Current as bilayer rods for conducting this experiment.

V. COPPER

Xinhua Liu (2012) In this experiment the author used a different metal compared to the other researchers. He used Porous Copper because it have low density, High specific surface area. And the Author used this metal because of the following properties they can be used in the light weight construction materials, they are energy absorption material sand they can be used in the filter separator.

VI. COPPER COMPOSITES

Manvandra Kumar Singh (2019) used Copper composites because it has outstanding wear resistance,

corrosion resistance, mechanical and electrical properties. In this experiment authorised copper because of its poor bonding between copper Matrix and the ceramics to achieve his project intention. Copper also has a greater wet ability. And as per the reports from the author investigation copper composites shows excellent mechanical properties with stainless steel reinforcements than ceramic reinforcements.

Hongshengding (2019) used copper crucible for his experiment .The author done simulation of electromagnetic field of continuous casting copper crucible. He used copper due to its high thermal conductivity and corrosion resistance .Coppers are used in the induction heating, melting and also in heat transfer process.

VII. CAST IRON

Shilpa (2020) used cast iron because castiron has high strength at reduced cost and it is more stiffer than Pureiron. Castiron are mainly used because of the ease of its castability .It can be molded into various complex shapes and sizes based on the industrial needs. The chemical composition of the cast iron is Mn, Si, C. These elements has its own advantage like wear resistance and corrosion resistance respectively. It has good vibration damping.

P.B.Chikali (2019) used ductile castiron to analysis the ductile properties. CastIron is alloy of iron, carbon and silicon. He chose castiron because many materials can be added to improve the properties of the castiron and also to increase the corrosion resistance, excellen tcastability, superior damping capacity, strength, ductility and toughness. Castiron are mainly used in the mechanical power transmission systems.

Jun Zheng (2018) Cast iron has the composition of 1-3%Silicon; 2.5-4% Candremainingare Iron. This composition makes the material more ductile and elastic. And the toughness and hardness of cast iron is increased than iron. As it has many benefits, the author used this castiron.

Samir Chakravarti (2018) The properties of iron are ductile, malleable, good wear resistance as well as good vibration damping and high machinability. To achieve this properties, the iron billets, bars, and slabs can be produced by casting. It is used in manufacture steel, construction of roads, railways, other infrastructure, appliances, and buildings.

Harshil Bhatt (2014) Cast iron is a binary iron-carbon of multi component Fe-C-X alloy that is rich in carbon and exhibit a considerable amount of eutectic in the solid state. With its relatively low melting point ,good fluidity, cast ability excellent machinability resistance to deformation and wear resistance cast irons have become an engineering material with a wide range of applications.

Battezzati (2013) Good vibration damping ability makes the cast iron to be used in major mechanical applications. In most production there are fewer parameters which must be considered during production. An important parameter is cost of the material. The cost of the cast iron is maintaining the cast iron incasting process along with its technical property of wear and corrosion resistance.

Rubén Lora (2011) He molded this material and poured in on a vertical tube furnace. Grey cast iron makes one of the most widely used cast material and it has some important properties. It has good vibration damping and good resistance to thermal fatigue. It has high compressive strength and good thermal conductivity.

U.C. Nwaogu (2010) preferred Cast iron in this experiment for its high hardness and toughness. It is ductile in nature and exhibits elasticity and further concluded that cast iron is also durable and in expensive one. They are used in making anchor for ships, automotive parts and in pipes to carry suitable fluids.

S. Guharaja (2006) The minimum casting defects of Spheroidal graphite cast iron were showed by various optimum levels of green sand casting parameters. The result that was the selected process parameters has been significantly affected by the casting defects of Spheroidal graphite cast iron rigid coupling casting has been indicated.

VIII. STEEL

B. Ravi (2007) used steel for feedability analysis due to its high tensile strength, fatigue strength and offers high toughness sand exhibits high corrosion resistant. Also steel is malleable in nature. As steel has many properties which is more suitable for sand casting, the author have selected this material.

IX. MILD STEEL

Sanjiv Kumar Tiwari (2016) The author suggesting many materials like Ductile Iron, Grey Iron, Mild steel. But he chooses Mild Steel Because of the large supply and many industries using mild steel for producing their products. They are used in machinery parts, cookware and pipelines.

X. ALLOY STEEL

Eugen Demler (2020) used Steel has experimental metal for his research. He chose steel due to its availability and many industries are producing lots for products out of steel. They also classified into many grades so that their mechanical and chemical properties can be modified for the need like strength, wear, corrosion and operating temperature. Author sees the advantages in steel usage and how can the mechanical and chemical properties can be altered by cooling and forging.

XI. CONCLUSION

From this review paper we are able to understand that each and every metal and alloys used by the researchers have unique, chemical, mechanical properties. And they chose them according to their own convenience for their research.

- Aluminium is used because it is highly ductile in nature.
- Copper is used because of its excellent thermal conductivity.
- Cast Iron is selected for its greater hardness and toughness.
- Steel is preferred for its good tensile strength.

REFERENCES

[1] Muhammad HuzaifaRaza, Ahmad Wasim, Muhammad Sajid, & Salman Hussian. (2020). *Investigating the effects of gating design on mechanical properties of aluminium alloy in sand casting process*. Available at: https://doi.org/10.1016/j.jksues.2020.03.004.

[2] J. Jensin Joshua, A. Abraham, & Eben Andrews. (2020). *Design of experiments to optimize casting process of aluminum alloy 7075 in addition of TiO2 using Taguchi method*. Available at: https://doi.org/10.1016/j.matpr.2020.05.164.

[3] Zhen Xu, Sixue Wang, Hongbin Wang, Hua Song, Shengli Li, & Xingyu Chen. (2020). *Effect of cooling rate on microstructure and properties of twin roll casting aluminium alloy sheet*. Available at: https://doi.org/10.3390/met10091168.

[4] Vishal N.Kaila & Indravadan B.Dave. (2020). *The influence of coating sand materials on shell mold properties of investment casting process*. Available at: https://doi.org/10.1016/j.matpr.2020.06.401.

[5] Swapnil Agrahari. (2020). *Effect of cooling rate on microstructures and mechanical property of Al 1230 alloy in a sand casting process*. Available at: https://doi.org/10.1016/j.matpr.2020.02.372.

[6] Shilpa. (2020). *A combinatorial approach to optimize the properties of green sand used in casting mould*. Available at: doi.org/10.1016/j.matpr.2020.05.465.

[7] Ayar MS, Ayar VS, & George PM. (2020). *Simulation and experimental validation for defect reduction in geometry varied aluminium plates casted using sand casting*. Available at: https://doi.org/10.1016/j.matpr.2020.02.788.

[8] Barot RP & Ayar VS. (2020). *Casting simulation and defect identification of geometry varied plates with experimental validation*. Available at: https://doi.org/10.1016/j.matpr.2020.02.575.

[9] Gres T, Nardi VG, Schmid S, Hoyer J, Rizaiev Y, Boll T, Seils S, Tonn B, & Volk W. (2020) Vertical continuous compound casting of copper aluminumbilayer rods. *Journal of Materials Processing Technology*. Available at: https://doi.org/10.1016/j.jmatprotec.2020.116854.

[10] Husain NH, Ahmad AH, & Rashidi MM. (2020). *Thermal analysis of 6061 wrought aluminium alloy using cooling curve analysis-computer aided (CCA-CA) method*. Available at: https://iopscience.iop.org/article/10.1088/1757-899X/788/1/012018/meta.

[11] Ramana MV, Kiran CS, & Rao VV. (2020). *Experimental investigation on the time-temperature history of Al-Si alloy while cooling in fresh and reclaimed silicate sand mould*. Available at: https://doi.org/10.1016/j.matpr.2020.09.322.

[12] Borikar GP & Chavan ST. (2020). *Optimization of casting yield in multi-cavity sand moulds of al-alloy components*. Available at: https://doi.org/10.1016/j.matpr.2019.12.305.

[13] Eugen Demler, Hans Jürgen, & Maier Florian Nürnberger. (2020). *Casting manufacturing of cylindrical preforms made of low alloy steels*. Available at: https://doi.org/10.1016/j.promfg.2020.04.333.

[14] Rodríguez-González P, Fernández-Abia AI, Castro-Sastre MA, Robles PE, Barreiro J, & Leo P. (2019). *Comparative study of aluminum alloy casting obtained by sand casting method and additive manufacturing technology*. Available at: https://doi.org/10.1016/j.promfg.2019.09.058.

[15] Manvandra Kumar Singha, Rakesh Kumar, & Gautamb, GopalJic. (2019). *Mechanical properties and corrosion behavior of copper based hybrid composites synthesized by stir casting*. Available at: https://doi.org/10.1016/j.rinp.2019.102319.

[16] P.B. Chikali & V.D. Shinde. (2019). *Analysis of machinability in ductile iron casting*. Available at: https://doi.org/10.1016/j.matpr.2019.12.064.

[17] Hongsheng ding, Xuesong Xu, Shenwangwang, & Haitao Huang. (2019). *Numerical Simulation and experimental verification of electromagneric field of continuous casting copper crucible*. Available at: https://doi.org/10.1016/j.promfg.2019.12.083.

[18] Xu Q, Xu K, Yao X, Zhang J, & Wang B. (2018). *Sand casting safety assessment for foundry enterprises: fault tree analysis, Heinrich accident triangle, HAZOP–LOPA, bow tie model*. Available at: https://doi.org/10.1098/rsos.180915.

[19] Chakravarti S, Sen S, & Bandyopadhyay A. (2018). *A study on solidification of large iron casting in a thin water cooled copper mould*. Available at: https://doi.org/10.1016/j.matpr.2017.11.676.

[20] Hodbe GA & Shinde BR. (2018). *Design and simulation of Lm 25 sand casting for defect minimization*. Available at: https://doi.org/10.1016/j.matpr.2017.12.018.

[21] Shahria S, Tariquzzaman M, Rahman MH, Al Amin M, & Rahman MA. (2017). *Optimization of molding sand composition for casting Al alloy*. Available at: https://www.kuet.ac.bd/webportal/ppmv2/uploads/14950 8365210.11648.j.ijmea.20170503.13.pdf.

[22] Tiwari SK, Singh RK, & Srivastava SC. (2016). *Optimisation of green sand casting process parameters*

for enhancing quality of mild steel castings. Available at: https://doi.org/10.1504/IJPQM.2016.074446.
[23] A.M. Lovatt. (2016). *Process and alloy selection for aluminium casting.* Available at: https://doi.org/10.1080/13640461.2000.11819358.
[24] Stefanescu D M. (2015). *Thermal analysis—Theory and applications in metalcasting*. Available at: https://link.springer.com/article/10.1007/BF03355598.
[25] Ajibola OO, Oloruntoba DT, & Adewuyi BO. (2015). *Effects of moulding sand permeability and pouring temperatures on properties of cast 6061 aluminium alloy*. Available at: https://www.hindawi.com/archive/2015/632021/abs/.
[26] Bhatt H, Barot R, Bhatt K, Beravala H, & Shah J. (2014). *Design optimization of feeding system and solidification simulation for cast iron*. Available at: https://doi.org/10.1016/j.protcy.2014.08.046.
[27] Harshil Bhatt, RakeshBarot, Kamlesh Bhatt, Hardik Beravala, & Jay Shah. (2014). *Design optimization of feeding system and solidification simulation for cast iron.* Available at: https://doi.org/10.1016/j.protcy.2014.08.046.
[28] Choudhari CM, Narkhede BE, & Mahajan SK. (2014). *Methoding and simulation of LM 6 sand casting for defect minimization with its experimental validation*. Available at: https://doi.org/10.1016/j.proeng.2014.12.393.
[29] Choudhari CM, Narkhede BE, & Mahajan SK. (2013). *Modeling and simulation with experimental validation of temperature distribution during solidification process in Sand casting*. Available at: https://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.402.7161&rep=rep1&type=pdf.
[30] Choudhari CM, Padalkar KJ, Dhumal KK, Narkhede BE, & Mahajan SK. (2013). *Defect free casting by using simulation software*. Available at: https://doi.org/10.4028/www.scientific.net/AMM.313-314.1130.
[31] Taufik RS & Sulaiman S. (2013). *Thermal expansion model for cast aluminium silicon carbide*. Available at: https://doi.org/10.1016/j.proeng.2013.12.197.
[32] Battezzati L, Baricco M, Marongiu F, Serramoglia G, & Bergesio D. (2013). *Melting and solidification studies by advanced thermal analysis of cast iron*. Available at: https://www.fracturae.com/index.php/MST/article/view/1077.
[33] Liu X, Li X, Jiang Y, & Xie J. (2012). *Effect of casting temperature on porous structure of lotus-type porous copper*. Available at: https://doi.org/10.1016/j.proeng.2011.12.478.
[34] Motoyama Y, Takahashi H, Inoue Y, Shinji K, & Yoshida M. (2013). *Dynamic measurements of the load on castings and the contraction of castings during cooling in sand molds*. Available at: https://doi.org/10.1016/j.jmatprotec.2012.09.014.
[35] S.Santhi. (2012). *Estimation of shrinkage porosity of a cast aluminium alloy*. Available at: https://www.researchgate.net/profile/Samavedam-Santhi-2/publication/273261132_Estimation_of_shrinkage_porosity_of_a_cast_aluminium_alloy/links/54fd464a0cf270426d11a881/Estimation-of-shrinkage-porosity-of-a-cast-aluminium-alloy.pdf.
[36] Kulkarni S & Radhakrishna D. (2012). *Effect of casting/mould interfacial heat transfer during solidification of aluminium alloys cast in CO2-sand mould*. Available at: https://dx.doi.org/10.14288/1.0073390.
[37] Rubén Lora**,** Attila Diószegi, & Lennart Elmquist. (2010). *Solidification study of gray cast iron in a resistance furnace.* Available at: https://doi.org/10.4028/www.scientific.net/KEM.457.108.
[38] U. C. Nwaogu. (2010). *New sol–gel refractory coatings on chemically-bonded sand cores for foundry applications to improve casting surface quality*. Available at: https://doi.org/10.1016/j.surfcoat.2011.02.042.
[39] A.A. Canale. (2010). *Thermal analysis during solidification of cast Al–Si alloys*. Available at: https://doi.org/10.1016/j.tca.2010.06.026.
[40] Cellini GS & Tomesani L. (2008). *Metal head-dependent HTC in sand casting simulation of aluminium alloys*. Available at: http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.538.89&rep=rep1&type=pdf.
[41] Ravi B & Joshi D. (2007). *Feedability analysis and optimisation driven by casting simulation*. Available at: https://www.researchgate.net/profile/B-Ravi-2/publication/228648823_Feedability_Analysis_and_Optimisation_Driven_by_Casting_Simulation/links/53f0dbaf0cf26b9b7dce10da/Feedability-Analysis-and-Optimisation-Driven-by-Casting-Simulation.pdf.
[42] S.M. Liang. (2007) *Thermal analysis and solidification pathways of Mg–Al–Ca system alloys*. Available at: https://doi.org/10.1016/j.msea.2007.07.025.
[43] Guharaja S, Haq AN, & Karuppannan KM. (2006). *Optimization of green sand casting process parameters by using Taguchi's method*. Available at: https://link.springer.com/article/10.1007/s00170-005-0146-2.
[44] Vijayaram TR, Sulaiman S, Hamouda AM, & Ahmad MH. (2006). *Foundry quality control aspects and prospects to reduce scrap rework and rejection in metal casting manufacturing industries*. Available at: https://doi.org/10.1016/j.jmatprotec.2005.09.027.
[45] Shabestari SG & Malekan M. (2005). *Thermal analysis study of the effect of the cooling rate on the microstructure and solidification parameters of 319 aluminum alloy*. Available at: https://doi.org/10.1179/cmq.2005.44.3.305.
[46] Meneghini A & Tomesani L. (2005). *Chill material and size effects on HTC evolution in sand casting of aluminum alloys*. Available at: https://doi.org/10.1016/j.jmatprotec.2005.02.114.

[47] Mirbagheri SM, Dadashzadeh M, Serajzadeh S, Taheri AK, & Davami P. (2004). *Modeling the effect of mould wall roughness on the melt flow simulation in casting process*. Available at: https://doi.org/10.1016/j.apm.2004.03.007.

[48] Sulaiman S & Keen TC. (1997). *Flow analysis along the runner and gating system of a casting process*. Available at: https://doi.org/10.1016/S0924-0136(96)02708-2.

[49] Y.W. Lee, E. Chang, & C.F. Chien. (1990). *Modeling of feeding behavior of solidifying Al–7Si–0.3Mg alloy plate castings*. Available at: https://link.springer.com/article/10.1007%2FBF02654250.

[50] Jarmo Tamminen. (1988). *Thermal analysis for investigation of solidification mechanisms in metals and alloys.* Available at: http://folk.ntnu.no/arnberg/taw32%20A.pdf.

