KML BRASIL

Mechanical Manufacturing

PRESENTATION OF THE FOUNDRY PROCESSES

Summary

OBJECTIVE

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OBJECTIVE

Inform the customer about our production process, from requesting a quote and the engineering studies to the inspection of the final product, detailing each step.

PROCESS SEQUENCE

1.0 ESTIMATE

Our first contact with the customer is based on a process of quoting the cast pieces, fabrication and reforms. The customer sends us a drawing of the part, whenever possible, which should include the following items:

1.1 **Material**
In international or proprietary standard with the content percentages of the five primary elements of a ferrous alloy, that is: Carbon, Manganese, Silicon, Phosphorus, Sulfur and of the alloy elements (if applicable), such as, Chrome, Nickel, Molybdenum, etc. In addition, the physical characteristics and the final hardness of the product must be mentioned, preferably in Brinell, Rockwell or Vickers. We have no problem receiving drawings in “inches”, “feet”, first or third dihedral angle, as our employees are trained in all the parameters mentioned. The estimate or the drawing must contain the form in which we are to deliver the casting: as cast, deburred and clean, semi-machined, machined and whether the pattern will be our responsibility or not.
1.2 It is important to mention that all documents sent by our customers are strictly confidential and restricted to only the employees in the commercial sector, the where the estimating and engineering sector is located, in the event that an order is placed.
1.3 We can receive customer data via email, WhatsApp, mail, etc. The analysis process then begins: Can we manufacture the desired items with quality and delivery time; Will our processes fully comply with the request and will we be able to control all the details specified by the customer.
1.3.1 First Step:
Calculation of part weight by means of geometric figures or by construction of a solid in parametric software. In the case of a sample piece, it is weighed on a calibrated scale. In the case of machining, we add the machining allowance based on tables that take into account the degree of surface roughness, in microns or inches.
1.3.2 If we are able to do complete the first step, we inform the customer.
1.3.3 Technical Estimate:
Our sector employee will carefully analyze the design sent to us, or ask for a sample in order to be able to determine which processes will be apply.
1.3.3.1 Manual molding process

1.3.3.2 Mechanized molding process
The molding process is selected in consultation with engineering and the following parameters are defined:
1.3.3.3 Number of pieces per mold, sand-metal ratio, mold dimensions (in the case of manual molding based on the pre-existing mold box table); in mechanized molding, the minimum sand wall thickness necessary to meet the metallostatic pressure at the time of a gravity pour.

1.3.3.4 Sand mold weight based on the volume in dm≥ versus the specific weight of the type of sand to be used.
1.3.3.5 If there is a need for special sand, such as chromite, the location of application and the quantity in kg to be used are determined.
1.3.3.6 At this point the charge metals can be calculated (if a standard is not extant); this calculation is done by means of stoichiometry based on the elements contained in our raw materials (scrap and alloy irons); we determine the cost per kg of the material, because in addition to the raw material we have to add the costs of electricity, labor involved in the process, depreciation of equipment and support sectors, etc.
1.3.3.7 Determination of metallic yield and consequent number of parts per run.
1.3.3.8 Analyzing the physical characteristics of the casting against the final hardness requested, the type of heat treatment to be applied will be determined: Normalization, Annealing, Quenching and Tempering, Solubilization, Tempering or Stress Relief. The final cost is based on the weight in kg and the number of pieces placed in the heat treatment oven. Special heat treatment such as “flame harding”, induction tempering, carburizing, etc., are carried out by qualified suppliers.
1.3.3.9 Deburring and Finishing
Calculated by using the estimated kg man hour per piece.
1.3.3.10 In case there is a need for machining, we contact the responsible sector that provides us with an estimate of the machine times to determine the cost of this step.
1.3.3.11 Product Inspection
What tests and certificates are required by the customer, if not requested, what tests do we have to carry out to obtain the requested parameters check.
1.3.3.12 Issuance of quality documents
Which must be issued, as requested by our client.
1.3.3.13 Packaging and shipment
Form of packaging for shipment FOB or CIF and dispatching
1.3.3.14 Preparation of the final estimate by the commercial sector and delivery to the customer.

2.0 RECEIPT OF CUSTOMER’S ORDER

2.1 Critical analysis of the order
Comparative analysis between the estimated and the requested for any divergences. If any exist, we inform the customer immediately.
2.2 Release of the Purchase Order in the ERP System, editing the flow to be followed based on the estimate and sending it to the relevant sectors.

3.0 MANUFACTURING PROCESS

3.1 Engineering

Divided as mentioned in the following items:

3.1.1 Drafting of the 3D drawing of the machined and as cast part in a parametric drawing program based on a drawing sent by the customer or a sample piece.

3.1.2 Determination of the theoretical weight of the part based on the 3D drawing of the part as cast (software provides the same when determining the material in it).

3.1.3 Analysis of the points of mass where it is necessary to place support based on parts that are not surfaces of revolution and for parts with a surface of revolution based on the Heuer circle to raise the cooling curve.

3.1.3.1 In the design and making of the pattern, loose-piece or matchplate, the cores and the determination of the parting line of the mold are based on the 3D drawing of the rough part. Preparation of 2D and 3D sketches of the patterns.

3.1.3.2 Verification of the pattern(s) and core box(s), even of the patterns sent by the customer as well as those for which we are responsible for manufacturing.

3.1.4 Determination of the cooling time sketches (cooling modules) based on the 3D drawing of the blank and determining the method of calculating the cooling module (cooling time). Area to perimeter ratio or volume to cooling surface ratio. At this moment, the volumetric contraction of the material in analysis is determined (for carbon steels, medium alloys and alloys, 7%; Mn Hadfield 6%).

3.1.5 With the cooling module determined, we determine the sand feeder with a consequent choice of the type of flask module to be applied, obeying the criterion of being 10%, at minimum, larger than the part module. The normal is 20% (for steels and white cast irons of all kinds).

3.1.6 Determination of the filling system based on the total volumes (Σ of the part weight and feeding system), metallotactic pressure(s) and theoretical filling time. This stage is where the section and shape of the downsprue and final dimensions of the distribution and attack system are determined. In the case of parts for manual molding, the entire filling system is made using refractory conduit.

3.1.7 Determining the total volume of the rough part we can determine the total volume for the mold to account for any shrinkage.

3.1.8 Preparation of the casting outline done in parametric 3D with all the observations related to the process.

3.1.9 Preparation of the pertinent Technical Sheet with all the observations related to the process.

3.1.10 Preparation of the auxiliary outlines in 2D and 3D, if applicable.

3.1.11 Review of the entire process of the items mentioned above.

3.1.12 Distribution of documents and drawings to the relevant sectors.

3.2 Programming and beginning the manufacturing activity

With the relevant technical documents, patterns and core boxes released, the start date of the molding and machining process is programmed.

3.3 Molding

3.3.1 Molding Process

We operate with two types of sand for molding, alkaline phenolic for parts manufactured in manual molding and urethane phenolic with gas catalyst ("cold - box") for small, medium and high series parts. Both types of sand are produced by continuous mixers, a constant target of preventive maintenance and replacement of the vanes when applicable. The molding strictly follows what is determined in the relevant technical document.

3.3.2 Mold Painting Process

Painting the mold, based on what was mentioned in the casting outline; painting by means of a sprinkler and brush with density control by hydrometer, several times during the day. Type of paints used, zirconite (alcohol or water soluble) and magnesium oxide (solvent alcohol).

3.3.3 Mold closing process, weighing and coring:

The cores are placed (pertinent technical documents state the number of cores per mold and types), the molds are closed and the ballast weights are placed, releasing them for pouring.

3.4 Melting Process

3.4.1 Melting

Our melting equipment consists of induction furnaces with two crucibles with a nominal capacity of 4000 kg (steel), 5000 (iron), 1500 kg (bronze), 200 kg (aluminum) that can operate in conjunction with a single converter, with a total of up to 5,000 kg of liquid steel. We work with qualified scrap or low carbon steel stamping scrap and alloy irons with known chemical composition and granulometry, acquired from qualified suppliers. All load metals are subject to load calculation based on stoichiometric calculation.

3.4.2 Preliminary Analysis After Melting

A sample is sent for preliminary analysis to determine the primary and alloy elements (if applicable). Analysis performed on an optical emission spectrometer, calibrated and verified once every five days based on the device's original working standards.

3.4.3 Adjustment of the molten load

Result of the preliminary in hand, we make the final adjustment of the load based on stoichiometric calculation and data of the alloy as already mentioned.

3.4.4 Adjustment of the temperature of the pour in the oven

Based on the relevant technical document, the power of the converter is adjusted to set the leakage temperature as indicated in the relevant technical documents. Temperature is verified by immersion pyrometer with disposable platinum-platinum-rhodium thermocouples.

3.5 Pouring Process

3.5.1 Our entire pouring process is carried out in siphon spout pans, made of refractory concrete or similar material and properly heated until they are red, when they can be used.

3.5.2 Pour liquid material from the oven into the pan

Pour temperature confirmed and recorded, material is poured from the furnace crucible to the pouring basin.

3.5.3 **Pouring of liquid material into the mold(s)**
The casting temperature in the mold is controlled with the same type of equipment already mentioned. Data for the correct temperature taken from the relevant technical documents. When verified, the melt is poured into the pouring basin and the downsprue, igniting the gases as determined by good pouring practice.

3.6 **Shakeout Process**
Always referring to the relevant technical documents, we perform the demoulding by a vibrating shake out method during the determined post casting time and the parts are sent to the deburring and finishing sector. The shakeout sand is sieved and sent to silos for reuse.

Note: In the cold-box process, we do not use recovered sand.

3.7 **Deburring and Finishing Process**
3.7.1 Cutting off the filling and feeding system.
3.7.2 Blasting of smaller parts is done in a jet shot cabinet.
3.7.3 Grinding and removal of burrs and ridges by means of disc grinders and grinder points with total removal of sand that adheres to the piece; and touch-ups based upon templates and similar devices to give the desired finished form.

3.8 **Heat Treatment Process**
Heat treatment is carried out as indicated in the relevant technical documents (temperatures, heating time, Austenitic phase field time and cooling method). See item 1.3.3.8.
3.8.1 There are cases in which parts return to the finishing sector for final finish.
3.8.2 Parts in which their dimensions allow to be placed in a shot blast table, return to the same.

3.9 **Product Inspection Process**
The tests and certificates required by the client are verified in a generic or individual Inspection and Test Plan for each piece and the inspection is made on the batch of parts sent to the sector, inspection sampling of at least 10% of the batch.
Process Ok, it is released to Packing and Shipping. Items that may have deviations return to the appropriate stage to undergo all the necessary corrections, requiring the re-inspection of all parameters.

3.10 **Packing and Shipping**
The form of packaging desired by the customer and the form of delivery are checked, whether FOB or CIF; if applicable, contact the carrier.

4.0 FINAL CONSIDERATIONS

4.1 The sequence of the above data may have their sequence changed with the removal or addition of processes, if applicable.
4.2 All of our employees have been trained for their duties and, if applicable, are updated.
4.3 We are available for any clarification.
4.4 We produce parts from 1.5 kg to 3800 kg in carbon steel, low alloy and alloys. Parts up to 4000 kg in Mn Hadfield steel.
4.5 We are in the process of implementing the ISO 9000:2015 Certification.
4.6 Part of the already existing Quality System, mainly the one referring to the manufacturing process mentioned in item 3.0) MANUFACTURING PROCESS, already exists and is in full operation.
4.7 All of our measuring equipment is consistently calibrated by a supplier qualified by RBC (Brazilian Calibration Network).
4.8 We also have a light/heavy metalworks unit specializing in machine bucket refurbishment of all types.
4.9 In item 5.0 Appendices there are examples of documents used in the manufacturing process that are part of our QMS (Quality Assurance System).

5.0 APPENDIX

5.1 Casting Data Sheet – Example
See below

5.2 Individual Inspection and Testing Plan – Example
See below

5.3 Melting Unit - Example

5.4 Heat Treatment Oven – Example

6.0 Prepartion:

6.1 Prepared by:

6.2 Claudio Esbérard
Company: Lacerda Funidos Industria e Comerciao de Fundidos
Location: Divinópolis – MG – Brazil

6.3 Thomas Mochen
Company: KML BRASIL – USA
Location: Norridgewock – ME – USA

6.4 João Keller
Company: KML BRASIL – BRL
Location: Rio de Janeiro – RJ - Brazil

Date: April 27, 2021

Revision: ZERO	CASTING DATA SHEET	Date: 5/12/2022

Drawing:	XXXXXXXX	LF	XXXXX

KML BRASIL

NAME:	LEFT BLADE
MATERIAL:	Steel alloy CrNiMo

MOLDING DATA

Qty pcs/mold:		1		Quantity of cores per mold:			3
Part Wt (kg)	28	Mold Paint		Types of cores per mold:			1
Sprue Wt (kg)	4.57	Zirconite Water:		Filling Sand:		Silica:	silica mix
Tree Wt (kg)	6.14	Zirconite Alcohol:	see outline	Facing Sand:		Cromite:	
Melt (kg)	38.71	Magnesian		Silica Mix:	X	New Silica	
Yield	72.33%	Box	see outline			Quantity	
Ballast Wt (kg)		150	Weight	Estimated	X	Actual	
Molding Process		Manual	X	Cold Box		Árvore:	
Molding Time		24 hours	X	48 hours		72 hours	
Molding Temperature		Ambient		Max 200ºC	X	250/300ºC	

MELTING DATA

Chenical Composition Desired

Carbon	Manganese	Silicon	Chromium	Nickel	Molibdenum	Copper	Phosphorous
0.2 0.25	0.8 1	0.3 0.6	1.1 1.3		0.2 0.25		MAX. 0.04

Sulfur	Titanium	Vanadium	Tungsten	Aluminum
MAX. 0.04				0.025 0.045

Predicted Pour Time	10 seg.	Actual	seg.
Pour Temperature	1600 a	1610 ºC (MOLDE)	

ATTENTION	BE CAREFUL WHEN POURING - DO NOT ALLOW SLAG TO ENTER THE MOLD
SPECIAL MELTING PROCEDURES	USE VG53 0.15% FLUX IN THE COLD LOAD AND 0.10%

IN THE METAL OF THE LADLE. CAUTION THAT THE MATERIAL DOES NOT OXIDIZE.

FINISHING DATA

Gating Cuts	Torch	Break	Graphite	Eletrode	Disc	Other	See Model
		X					x

Trimming	Bristle	Disc	No trim	Cut Temp	Ambient	X
		X			MAX 200ºC	
					250 a 350ºC	

OBS.: CAUTION WHEN BREAKING GATING ==> IF NECESSARY MAKE A NOTCH WITH A DISC GRINDER USING CARE TO NOT NICK THE PIECE. PARTS MUST GO TO QUENCHING 100% FINISHED

HEAT TREATMENT DATA

HEAT TREATMENT	Normalizing	Annealing	Quenching	Tempering	Solubilization
	X		X	X	

Temperature Range(º C)	Normalizing	Annealing	Quenching	Tempering	Solubilization
	880/900		External	External	

NOTES: RAMP UP HEATING AT 100°C/HR ==> REST TIME IN THE AUSTENITIC REGION OF 80 MINUTES

EXAMPLE

Cooling Medium:	Normalizing	Annealing	Quenching	Temperinig	Solubilização	Especiais
FORCED AIR		OVEN	NA	STILL AIR	WATER	NA
STILL AIR	X					

Prepared by		Approved by		Date	5/12/2021

Date :13/08//2022

KML BRASIL

PIT No: 13082020L

LF No:	Design No:	Sequencial pc No:	

INSPECTOR : (Name) SIGNATURE

ANALYSIS	Sampling	Applicable	Approved	Disapproved	Obs .
DIMENSION	30%	X			
WARP E TWIST	100%	X			
VISUAL	100%	X			
CHEM. COMP.	By heat	X			
HARDNESS					
RESIDUAL MAGNETISM	10%	X			
MAGNETIC PARTICLES					
PENETRATION FLUID					
TRACEABILITY					
PACKING					
PAINT	See note.				
ULTRASONIC					
CRACK DETECTION	30%	X			

STANDARDS TO BE APPLIED IN THE PROCESS

1) **CRACK DETECTION TEST → VISUALLY VIA FLASHLIGHT AND LOUPE → MAINLY IN CORNERS AND RADII.**

2) **WARP AND TWIST TEST→ CHECK IN TWO DIRECTIONS→WARPED PARTS MUST BE CORRECTED**

EXAMPLE