FAQ, Vacuum assisted Lost Foam Casting Moulding Process.

Modernizing Foundry

GD Mishra, steel@gdmtechnics.com
CEO, General Dynamic Multi Technical Consultancy LLP
A Mechanical Engineer and MBA having 30 years of diversified experience in Product Application and implementing new Concepts and Project in India. Liquid Helium, Brewpubs, Lost Foam Castings(v-LFC) and V-Process (VPC) are few of the Products and Processes introduced in India by his efforts.

Vacuum assisted Lost Foam Casting Process: (vLFC) had been introduced in India in 2002 at Electrosteel in collaboration with Xinxing Ductile Iron Pipe Co Ltd [1]. But the real acceptance of vLFC Process started Since 2015 with various foundries in India for castings parts for Submersible Pumps, Valves, Ductile Iron Pipe Fittings, Differential Housing for Tractors, Engine Blocks and Railway Castings, at Kolhapur, Raipur, Rajkot, Vadodara and Pithampur.

Lost Foam Casting

Today, Vacuum Assisted Lost Foam Casting (v-LFC) Process is finding a great acceptance in foundries in China which have more than 3500 LFC foundries with different variants as shown in Fig.1. Recently foundrymen in India have generated interest into this process which is quite economical and reduces the foundry variants to about 40%. v-LFC uses Free-flowing sand without any binders and sand is re-used after cooling and removal of dust if any. The cost of production by v-LFC is also reduced between 15- 30%

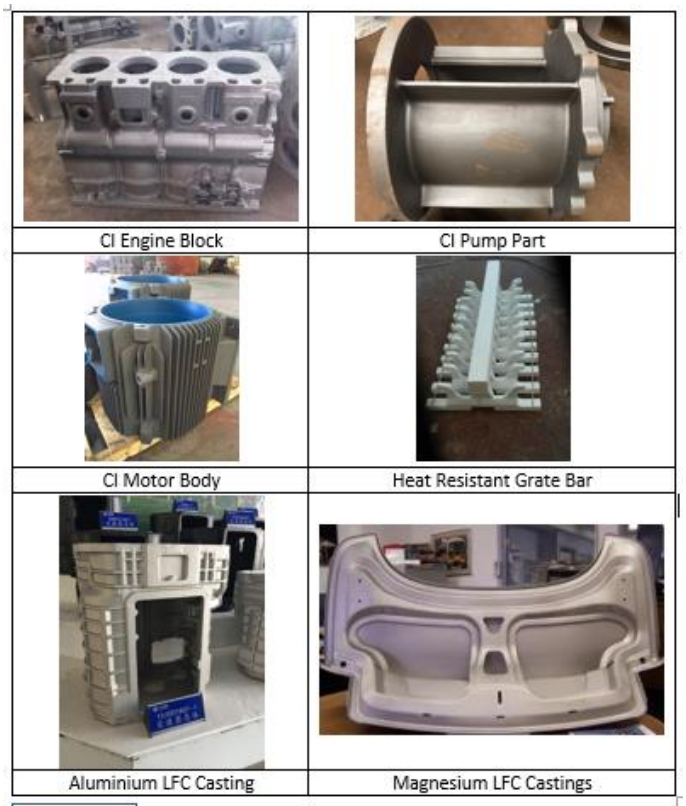


Fig. 3.

depending upon the casting, its profile, need of cores and metallurgy.

How, LFC is most Economical Moulding Process today

1. Most economical moulding process for 20 kg to 350 kg castings. Any size & shape weighing between 10-12 tons is also possible.
2. A kg of EPS (Expanded Polystyrene)/STMMA (styrene methyl-methacrylate) can produce 250-300 kg of casting.
3. Intricate parts can be cast
4. No Core, so no Core cost
5. No Rejections due to Core Shifting
6. No Fins so almost nil fettling
7. Faster Delivery, Satisfied Customers, Lesser Opportunity Cost.
8. Very good Surface Finish upto 150- 200 RMS can be achieved, without big efforts.
9. Machining work minimized, 2 mm max at tool point.
10. Sand reused with only 1% wastage
11. Steel, Ductile Iron & Grey Iron, Non-ferrous all can be cast very successfully
12. Environmentally friendly and Pollution Free workshop.

v-LFC Process Diagram

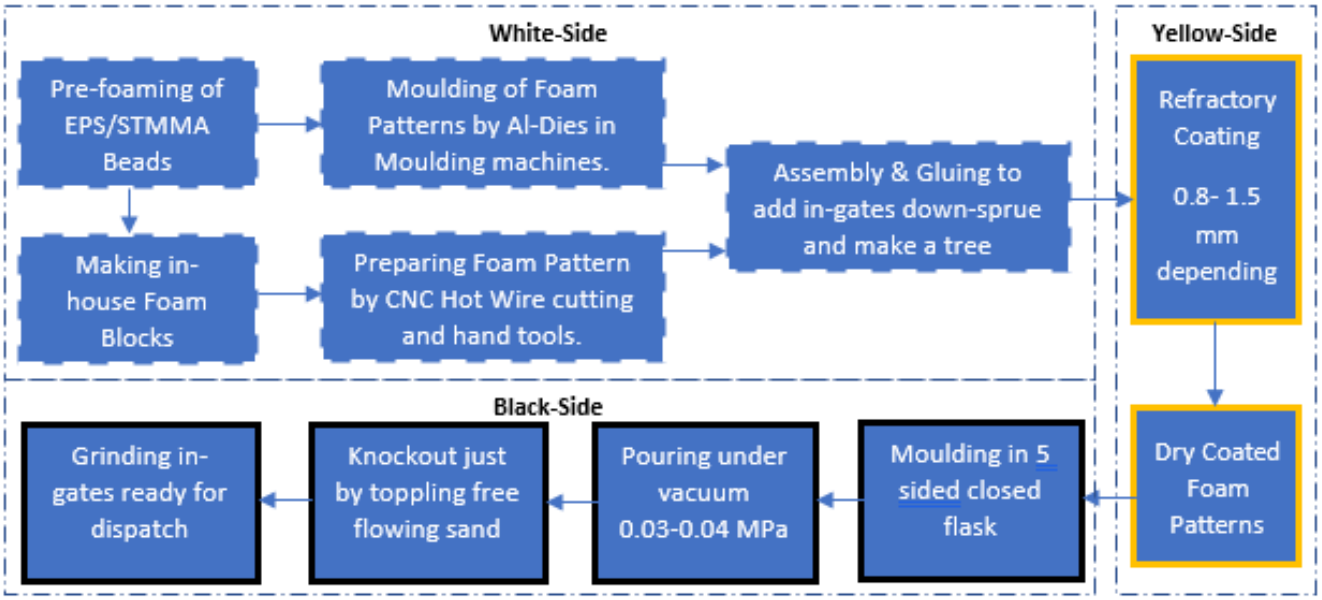


Fig. 2. Vacuum assisted Lost Foam Casting Process (v-LFC)

Acceptance of v-LFC

v-LFC Process has been successfully adopted for Grey Iron, Ductile Iron, Mn-Steel, Carbon Steel and recently expertise is being developed in special Alloy Steels too. Quite a few successful Aluminium Foundries by LFC are operating in China. Castings of Magnesium & Titanium Alloy castings is being practiced in Europe.

Generally, when we work out the viability for adoption of this process, we ask for present yield, casting weight, moulding sand weight, core-weight, the higher it is, higher is the margins for savings. But the most important aspect is the technical viability in all cases and the acceptable levels of rejections under various test condition. If similar castings have not been successfully achieved elsewhere in the world by v-LFC we should refrain in the earlier stages of adaptation of the LFC process in our foundry.

vLFC in terms of Saving [2] :

1. Higher Liquid Metal Yield of around 85% to 93%, is direct saving of energy.
2. Lower casting weight by 6-12% further adds to the energy saving as lesser metal needs to be melted.
3. Lower machining time due to lower machining margins made possible on account of better dimensional accuracy.
4. Net impact on energy saving around 27% *
5. Labor productivity improvement by 46% *
6. Productions cost reductions of 20% to 25% are possible on simple cored items. *
7. Productions cost reductions of 44 - 50% are possible on complex castings. *

Other Savings in LFC Process

1. Sand reclamation, the primary attrition and the secondary attrition to achieve 75% reclamation level and the thermal attrition to achieve total 95% reclamation level needs lots of electricity and gas, while the Lost Foam Technology only needs sand cooling and recirculation.
2. Because the LFC process sand does not stick to the casting surface and there are no fins, so no energy by way of hammering, grinding and chipping is needed for knockout and fettling of castings. Saves, time too.
3. Machining allowances of 1.5-2 mm at tool point so less machining needed, saves Energy and Time.
4. Finished-Goods Inventory goes down drastically.

FAQs for vLFC Process

What weight of castings are recommended?

Start your foundry with a grey iron casting in the weight range of 40-80 kg and stabilize the results. Then after you can graduate to higher weight and lower weights upto 250 g.

1.3 ton Steel Castings by LFC

150 g Castings by LFC

Whiteside:

What should be target Density of Foam Pattern?

Alloy Type	Pouring Temperature	Density of Foam Pattern
	°C	kg/m³
Aluminium Alloys	790-700	22-24
Copper Alloys	1260-1040	20-21
Grey Iron	1410-1340	≤21
Ductile Iron	1455-1425	≤21
Cast Steel	1650-1595	≤18

Will the cost of production increase if we use STMMA-FD / STMMA in place of EPS?

No; cost per kg of casting is not more, and moreover extra cost incurred is compensated by heavy reduction in rejections. EPS is suggested to be used only in cases, where machining is not required.

What is the challenge is making Foam Patterns?

To obtain the right density of foam patterns from moulding machines, and yet make patterns with smooth surface without any visual open beads.

Why is the foam pattern cost so low per ton of casting?

The key is the density between Foam Pattern and Castings. Say for example Iron Density is 7.874 g/cm³ and that of foam pattern will be 0.02 g/cm³, means foam pattern is 394 times lighter. In practice we take it 300 times for all estimations. In other words, with 1 kg of Foam you can make 300 kg of castings.

What is the thinnest wall thickness that can be cast?

We can cast up to 3mm if supported by higher thickness of 5 mm at a distance of 10 mm.

What tolerances can be maintained in vLFC Process?

Tolerances of 0.127 mm for the first 25.4 mm and 0.0762 mm per 25.4 mm thereafter are expected for castings produced from Machine Moulding Foam Patterns. Tolerances up to 0.051 mm 25.4 mm are possible from CNC machined foams from Foam Blocks, which can be used for small batches, replacement parts, or prototypes.

Yellow Area, Coating of Patterns & Drying:

The Coating for Grey Iron, Ductile Iron, Steel, Mn Steel, Aluminium, Copper alloys all need special coatings.

How many coating layers is needed and what care is required for drying?

A coating thickness of 0.8 to 1.5 mm is prepared with 70-80 Baume coating or 55 Baume Coating in 2 layers. Air Permeability has to be maintained at about 90.75 $cm^3/s/cm^2$ ± 10%.

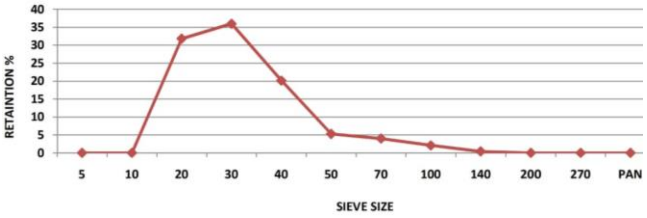
The Coating has to be dried at a controlled Temperature range of 48-53 °C at a Relative Humidity of 18-22%.

Blackside:

What type of sand is required?

1. Free flowing without binder washed Silica Sand 25-40 AFS without dust and fines less than 0.08 mm 0%, is recommended.

A typical Sieve Size Analysis of recommended Sand.



2. Ceramic Sand of similar AFS can be used for making heavy castings of more than 500 kg and more; also for castings of Engine Blocks, Cylinder Heads, Exhaust Manifolds etc. It is expensive but has more than 10 times usage life than Silica Sand.

What is Compaction Table and 3D Vibration?

Free flowing sand has to reach every pocket of the Coated Foam Pattern and well compacted to the surface of pattern. This is ensured by sand movement in XY & Z direction or its various combinations with the help of a set of eccentric motors at 1800 to 2400 rpm.

How Vacuum helps in moulding in LFC Process?

Compacted sand in the closed mould has to be subjected with negative pressure, vacuum of 200-400 mmHg depending upon wall thickness and weight of casting.

Vacuum provides following actions:

1. Mould Hardness
2. Extraction of Gases generated by foam disintegration, arresting the pyrolysis process and sucking away metal fumes.
3. Initial suction of heat energy for 2-3 minutes
4. Increase the liquid metal flowablility.

What happens to Foam Pattern after burning?

We can claim foundry pollution tending to Zero:

EPS= C_8H_8 **$CH_2=CHC_6H_5$**

$C_8H_8(l)+10O_2(g)$-----*(burning)* ------->$8CO_2(g)+4H_2O$									
Casting Weight				1000	kg	Only Water & Carbon Dioxide released when burnt openly			
EPS Needed				3.3	kg				
Styrene Monomer by weight			2%	0.067	kg	67	g		
MAX yield of toxic products in smouldering (no Oxygen conditions)						0.003	µg/g		
				66.7	g	0.2	µg, if un-burnt gas is released		
*** Natural Styrene concentrations in outdoor air are generally <1 µg/m³**									
* The styrene content of cigarette smoke has been reported to be 18–48 µg/cigarette									

What is the future of vLFC Moulding Process?

The acceptance of Lost Foam Casting Process is increasing in last 5 years. About 7000 ton/month capacity is being added in 2022-23, as green field project. It's a clean foundry, conserves sand, with less wear & tear, pollution free and reduces production cost from 15-35%.

---***---

References:

1. https://www.financialexpress.com/archive/chinese-technology-to-drive-electrosteel-ductile-iron-plant/43228/
2. * https://www.osti.gov/servlets/purl/1024103 Page 106 Paragraph 2 & 3)
3. https://www.euro.who.int/__data/assets/pdf_file/0018/123066/AQG2ndEd_5_12Styrene.pdf