

An Experimental Examination on Ice Pattern for Casting Process

T Bharath, J Sarathkumar Sebastin

Abstract: *The casting process has come to wide range of use in manufacturing process. Wooden, aluminum and wax are mostly used materials for pattern in the casting. However, it contains some limitations such as expansion of wax pattern, cracks in ceramic, complexity limitation in wooden pattern and removal of wooden pattern from sand mold etc., in the light of this, the work attempts to use ice pattern for mold making and sublimating ice pattern to create cavity in the mold for pouring. Ice pattern can be produced with aid of rapid freeze prototyping (RFP) or by traditional ice mold method. Integration of RFP/Traditional ice mold method with sublimated ice in casting process allows the quick creation of complex metal parts. Here, mold is produced by ice pattern and then ice pattern is removed by sublimation process (sublimation is the process of direct conversion of solid phase to vapor phase of matters) to create cavity. The advantages of no parts geometric complexity problems, No need of parting line design, less complex limitation, sound casting, clean and less cost of process operation, and better performance. This paper will present our creation study on sublimation of ice pattern in greensand for mold making for casting, and results of the cast piece obtained from sand casting process.*

Keywords : Rapid freeze prototyping, ice pattern, sublimation of ice, green sand, sand casting process.

I. INTRODUCTION

Foundry practice deals with the process of making casting in moulds, formed in either sand or material. This is found to be the cheapest method of metal shaping. The main aim of the project is to sublimate the ice pattern to create the mould cavity for sand casting process. Here, ice pattern is used to create the mould, then ice is sublimated to create the cavity in the mould and ice pattern can be created by traditional moulding method.

The sublimation of ice pattern from traditional moulding method is possible to make accurate casting with short period of time. This process is valuable in case small quantity of complex metal parts and for accurate casting. In this work we have to use the traditional green sand with ice as a pattern, to create the mould cavity, while creating the cavity sublimation process is carried out to remove the ice from the pattern (the process of direct conversion of solid phase to vapour phase is called as sublimation). The most common ice shape used as a pattern for casting, the sublimation help to maintain the fine surface finish of the casting material when compare to other

process. These limitations are eradicated by the effective implementation of sublimation of ice pattern for casting process.

II. MATERIALS AND METHODOLOGY

(a) Material used for low temperature casting process

The sand used for regular casting process should have different characteristics from sand used for casting process with ice as a pattern. For example, the sand used for casting process should contain less water, not freeze at sub-zero temperatures, and has medium drying speed.

(b) Green sand

Green Sand is used to create mold. Once the sand is rammed on the pattern, it is able to hold its shape due to its unique mixture. At this stage, the casting is almost ready for pouring as soon as the cores are in place. Here, normal foundry green sand is used for this process.

(c) Separating agent

Splitting material is needed for casting process with ice as a pattern because mold contains water and binders this may interact with ice pattern which causes damage in ice pattern surface. The split up material should be, in-soluble when mixed with water, should not react with water, and not freeze at below zero temperatures and Non-toxic, and no pollution. Silicate oil and kerosene can be used as a separator (1:1 ratio) and coated in ice pattern surface. Before coating the separator it cooled to pattern temperature.

(d) Sublimation of ice pattern

Sublimation is the process of changing the ice (solid) phase to vapor (gas) phase. In (FCP) process ice pattern is melted by keeping it in the room temperature. But in the study we sublimated the ice to create the mold cavity. For the sublimation of ice the atmosphere should be maintained in vacuum at 0 degree Celsius .this point is called triple point. At this point ice can be directly converted into vapor and this process is called sublimation. To convert ice from solid phase to vapor phase the atmosphere should be maintained at 614Pa-617Pa and 275 Kelvin (0.01°C). At this condition, it is practicable to convert all substance to ice, vapor or water by making minute changes in pressure and temperature.

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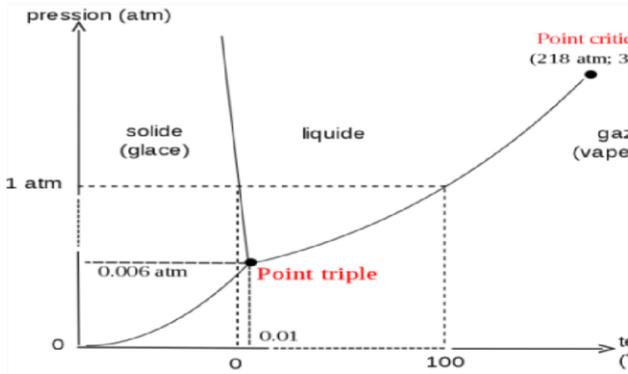


Figure 1: Triple point of water

Since the following study is based on the process of casting with sublimation of ice patterns, the ice patterns can be built by traditional moulding method. In order to evaluate the casting accuracy, the ice pattern should be simple and easy to measure.

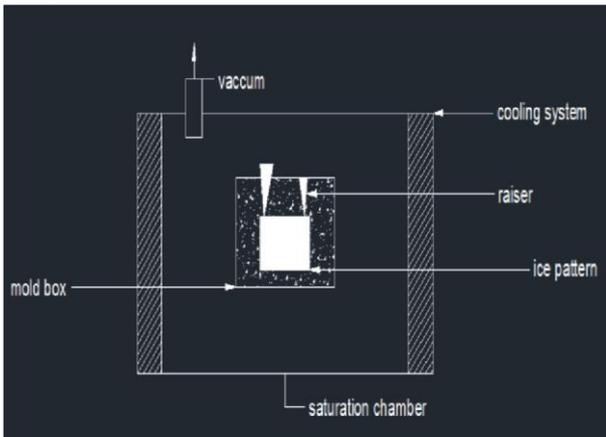


Figure.2: CAD Model

Components used are, vapor compression refrigeration system, vacuum pump and digital thermometer.

Vapor compression refrigeration system

Refrigeration with Vapor-compression or vapor compression refrigeration system, in which the refrigerant undergoes phase changes, Vapor compression refrigeration system is used to maintain the mould box sub-zero temperature, because pattern is solid ice for that temperature must be sub-zero to maintain the shape of the ice pattern.

Vacuum pump

Vacuum pump is basically going to lower the pressure of the container, the container should be rigid because as you withdraw gas from the container the atmosphere will instantly begin to weigh upon the container from all sides with its pressure range. Here, our work is nothing but an air compressor except the discharge does not get pumped into a vessel. The intake is piped to the vessel to be vacuumed instead of atmosphere.

Digital thermometer

Thermometer is a device used to measure the temperature of the refrigerated chamber. There are many types of thermometers in general, here we used digital wired thermometer.

(e) Working principle

Casting process using ice pattern is simple procedure which is used as pattern for creating mould cavity in this project ice is created using ice moulds then the ice is removed and this ice is used in mould making to create the casting at the same time

atmosphere of the mould making is maintained at 0°C and pressure range of 615pa, so that the ice can be converted into vapour and mould cavity can be created. Firstly, ice is placed on the mould box and sand is rammed over the ice pattern and then the ice is sublimated after this process pouring, solidification, and knockout is carried out.

Steps involved in this work are, (i) Ice pattern is created by using traditional moulding method, (ii) Mould material is cooled to sub-zero temperature, (iii) With the help of ice pattern create the mould cavity for casting (iv) Sublimation process for mould cavity formation, (v) After sublimation mould cavity is created by using ice pattern and (vi) Pouring & knockout.

III. RESULTS & DISCUSSIONS

Mould making experiments with ice pattern and then sublimating the ice pattern to create the mould cavity as shown that the time taken for sublimation of ice pattern in the mould differs from the volume of the ice cube pattern. Our work is taken for simple ice for different volume, time taken for sublimation of ice cube for small volume is less compare to sublimation of higher volume. Sublimation condition was 625 Pascal and -2degree Celsius. Ice is used to make the patterns and to create the mould cavity to overcome the limitations in traditional casting process. After repeated experiments it can be absorbed that it take nearly 80min to sublimate the ice to create the mould cavity and to produce casting. Casting produced by using ice pattern had some surface pores and the shape of the pattern was stable and complex shapes can be done using this pattern so this process can eliminate some of the limitations in traditional method.



Fig. 3. (a) Ice pattern

After the casting process the cast piece get tested for hardness and surface finish, Rockwell hardness test and surface finish test results are attached below.



Fig.4. Casting with help of ice pattern (Final Product)

Table: 1 Rockwell hardness Test

SL.No.	Load/ kgf	Scale	A	B	C	Average/HRB
1	100	B	92	100	97	96.33
2	150	B	95	94	104	97.67
3	250	B	116	99	104	106.3

An experimental study has been developed to the study of sublimation of ice pattern for casting process.

Table 2: Surface finish test

Surface Finish	Rate mm/s	Range (mm)	A	B	C	Avg.
Before	0.5	10	2.76	2.001	2.331	2.36
After	0.5	10	0.23	0.221	0.228	0.228

IV. CONCLUSIONS

The experiments conducted on this study have demonstrated the acceptably of making mould cavity by ice pattern. The Rockwell hardness test helps understand the hardness of sand casting with ice pattern, and surface finish test helps understand of surface smoothness of the cast piece. The future work will be focused on improving the surface finish of the cast piece and better strength with reduced in porosity of the cast piece. Application of ice pattern should be another important plan of our future work.

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