AUTOMATIC CASTING INSPECTION BY ACOUSTIC EMISSION TECHNIQUE

[1]Vikas Ingle, [2]Chandrashekhar Randve, [3]Ashwini Belavi, [4]Shweta Kolkur,
[5]Shrivardhan Shende, [6]Prof. Dr. K. H. Inamdar
Student, Department of Mechanical Engineering (B. Tech. Mechanical),
[6]Profrssor, Department of Mechanical Engineering
Walchand College of Engineering,
Sangli-416415, India

Abstract: The problem of defects in casting is widespread throughout the foundry industry and their detection is of paramount importance in maintaining product quality. Defects are caused because the metal is weak when it is hot and the residual stresses in the material can cause the casting to fail as it cools. Various defects observed are blowholes, misrun, drops and pores that greatly influence the material ability to withstand various loads. Defects act as region for stress concentration initiating crack. Ultrasonic testing is used to determine these defects. But this inspection method is slow and expensive. In order to minimize the cost and speed up the inspection process, acoustic emission technique is used.

Keywords: Acoustic Emission Technique, Casting Defects, Foundry Industry.

I. Introduction

Quality is defined as the fitness for use or purpose at the most economical level. The two important concepts of quality are: Firstly, the finished product must meet the established specifications, and secondly, customer's satisfaction is derived from quality products and services. The various meanings of quality are the fitness for purpose, conformance to requirements, grade, and degree of preference, degree of excellence and measure of fulfilment of promises. The factors controlling the quality of design are the type of customers is the consideration, environmental conditions and special requirements of the products. The objectives of inspection are to reduce company's cost through reduction of the losses due to defects, less rework, less sorting, fewer customer return etc.

Acoustic emission is a non-destruction testing of material. Acoustic emission is the transient elastic waves within a material, caused by the rapid release of localized stress energy. The method of acoustic testing will be carried out either by measurement of the frequency of free vibrations of an element (casting) or by measurement of the time of the vibrations decay after their excitation, i.e. in measurement of the damping capacity. The obtained value of the first resonance frequency equal to the frequency of free vibrations, or the time of vibration damping in the tested casting (element) are compared with the frequency of free vibrations or with the damping time of a reference casting (element) satisfying all requirements of the Technical Acceptance Conditions (TAC).

II. Literature Review

S. Nishani [1] have given review about the use of acoustics as non-destructive techniques in agro-industry. They have explained that the perishable commodities after maturity they undergo the stage of ripening and tissue softening. The change in texture of fruits and vegetables occurs due to the breakdown of pectin substance in the middle lamella and the measurement of tissue softening is an important parameter to determine the shelf life of that commodity. In this review they reported about the Acoustic Vibration Technology (AVT), a non-destructive method of estimating the quality parameters of the food products. This technique was employed to detect responses to imposed vibration of intact food material using a shaker.

A. Białobrzeski [2] have given explain about designing and putting in operation of a stand for sonic testing equipped with modern and readily available numerical devices and with the author's own computer program, which enables recording and analysis of acoustic fields and of the frequency of free vibrations in selected castings made from Fe and Al alloys, and specifically also from magnesium alloys, and mastering the technique of making such tests along with their practical application in assessment of the quality of castings made from magnesium alloys and investment castings made from carbon steel.

M. Tasic [3] have explained about Analyses of possibilities of monitoring the crystallization process of continuously cast special brass alloys with acoustic emission and for establishing a correlation between the microstructure and the recorded acoustic emission signals. With appropriate selection of parameters for gravitational casting process, continuous casting was performed and samples with a macrostructure typical of continuous casting were obtained. A laboratory plant for the simulation of the continuous casting and for the analysis of the crystallization process with acoustic emission was designed. To check the obtained results, after completion of the crystallization process, the samples were submitted to external with mechanical loading. The acoustic activity by loading is in accordance with the results of on-line monitoring of the crystallization process with acoustic emission. The results obtained show that it is possible to use the acoustic emission for monitoring the crystallization process by continuous and gravitational casting.

Barnes [4] have proposed that in theatres, public buildings and working areas require additional absorbing material to improve their acoustic performance. A lightweight broad band panel space absorber was formed from a fabric membrane pulled taut over a high-density polyester blanket supported by a perforated metal backing. By hanging the panel on different length spacers, a variety of air gaps can be created between the wall and the perforated metal sheet. This report considers ways to improve the low and mid-band frequency performance of the panel by adjustment of the cavity depth, varying the thickness and density of the acoustic insulation, and by inserting a septum into the cavity.

Parkinson [5] proposed that an experimental study has been carried out on the use of alternating strips of materials to produce wideband absorbers. The absorption of a film faced foam was successfully combined with the absorption of a plain foam by combining the two materials in strips. Excess absorption (more than the average of the constituent strips' absorption) was found in each case. The strip absorber comprised of foam and film faced foam had greater wideband absorption than a similar absorber with the materials layered parallel to the backing surface (film sandwiched between two layers of foam) at 24 mm total thickness but not at 48 mm thickness.

S Amares [6] state that noise is always treated as a nuisance to human and even noise pollution appears in the environmental causing discomfort. This also concerns the engineering design that tends to cultivate this noise propagation. Solution such as using material to absorb the sound have been widely used. The fundamental of the sound absorbing propagation, sound absorbing characteristics and its factors are minimally debated. Furthermore, the method in order to pertain sound absorbing related to the sound absorption coefficient is also limited, as many studies only contributes in result basis and very little in literature aspect. This paper revolves in providing better insight on the importance of sound absorption and the materials factors in obtaining the sound absorption coefficient.

III. SETUP DESCRIPTION

Major components used in model are as follows:

(i) Conveyor Belt.
(ii) Setup Stand.
(iii) Testing Chamber/Cell.
(iv) Excitation Mechanism.
(v) Casting Detection Unit
(vi) Recording Unit.

Figure of setup is as shown below

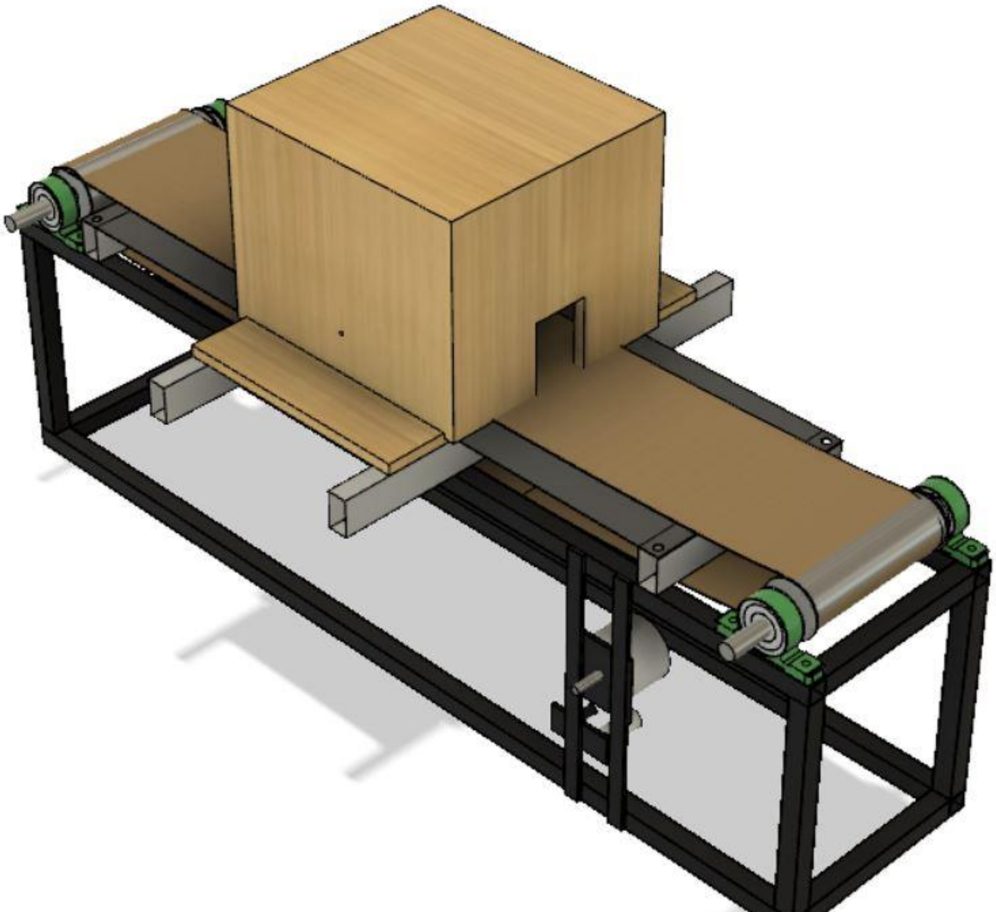


Fig 1: Virtual Image of Setup

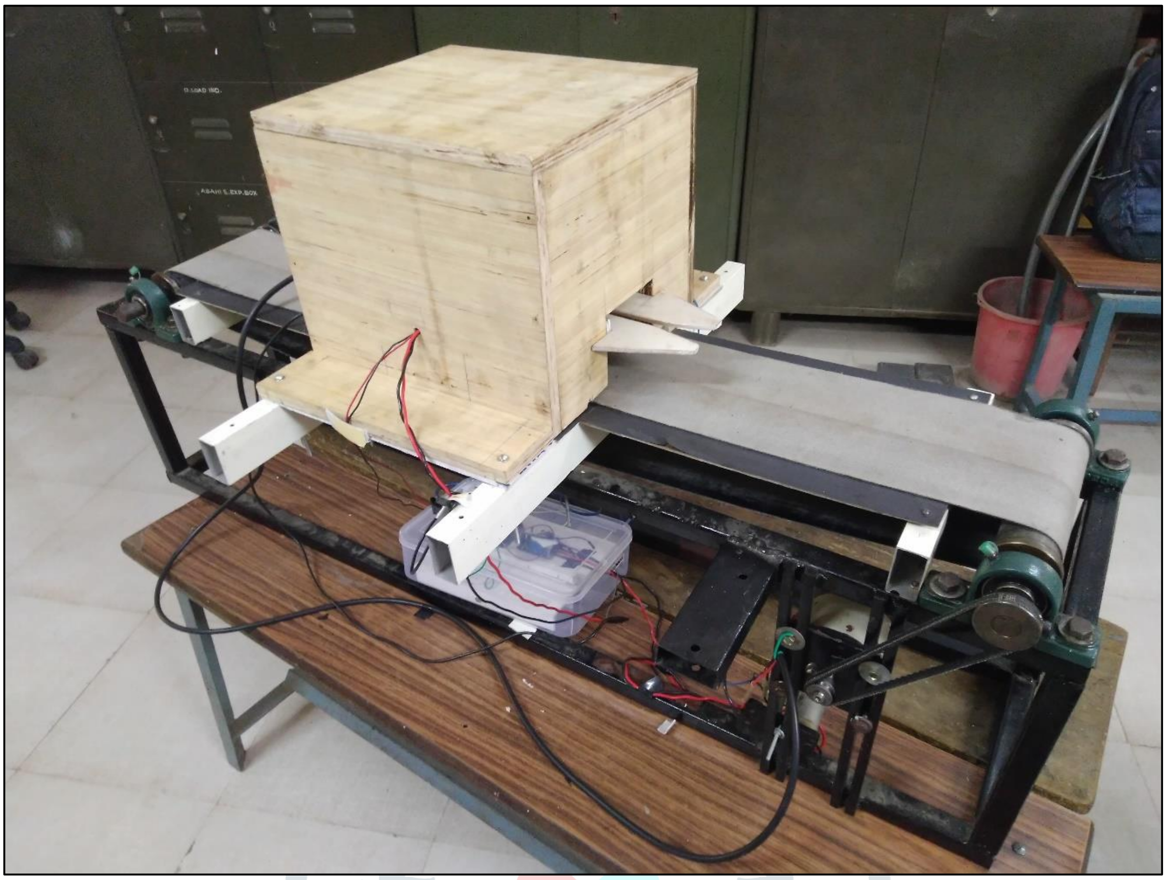


Fig 2: Image of the Prototype Used for Inspection of Casting

IV. LOGIC

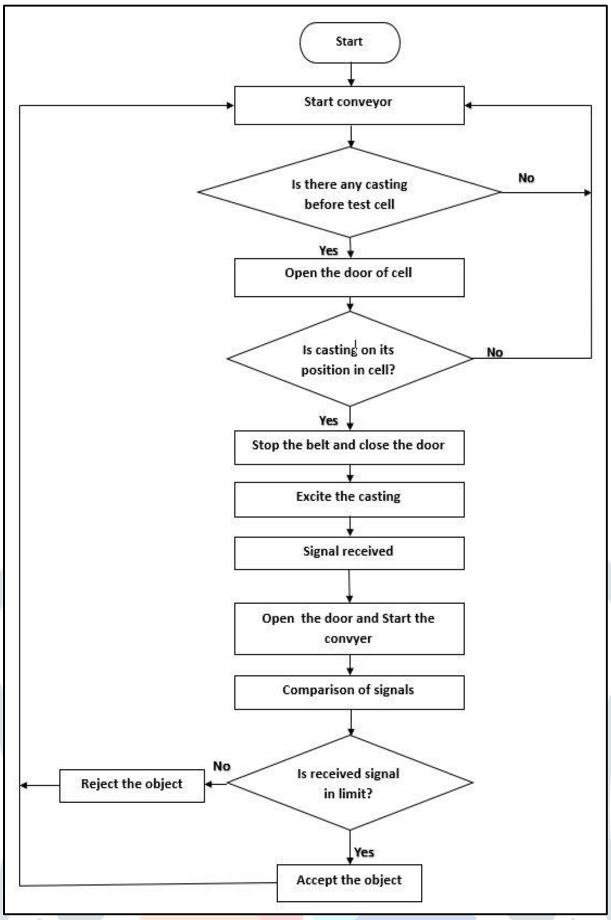
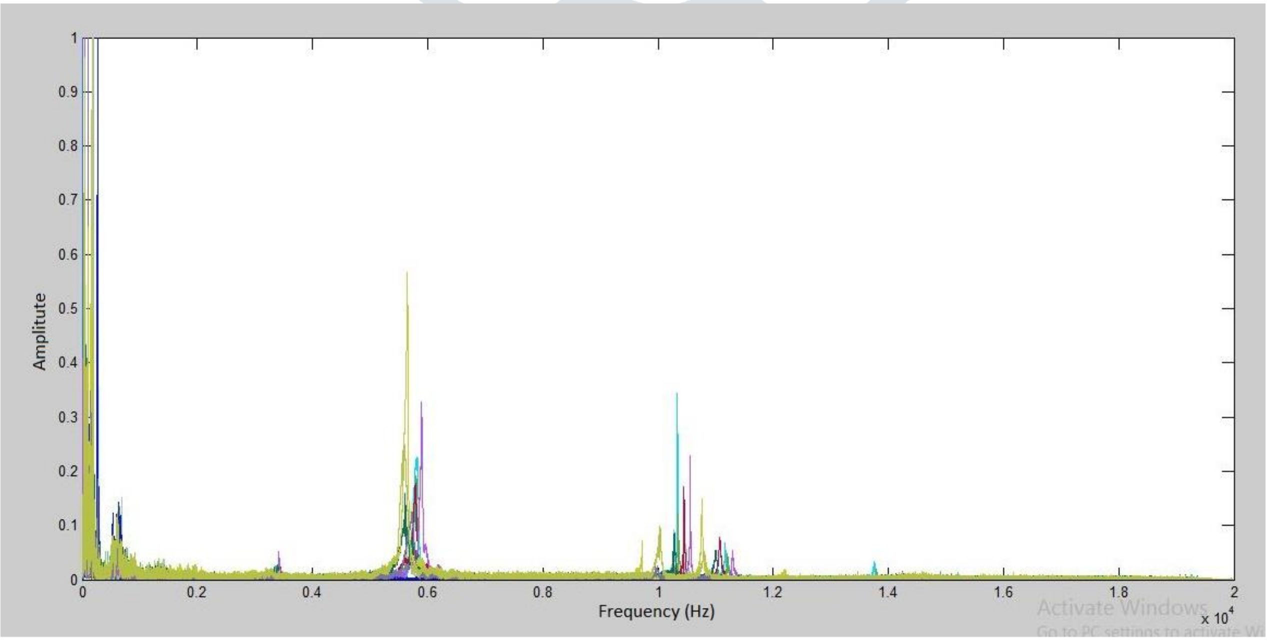


Fig 3: Algorithm for Defect Detection

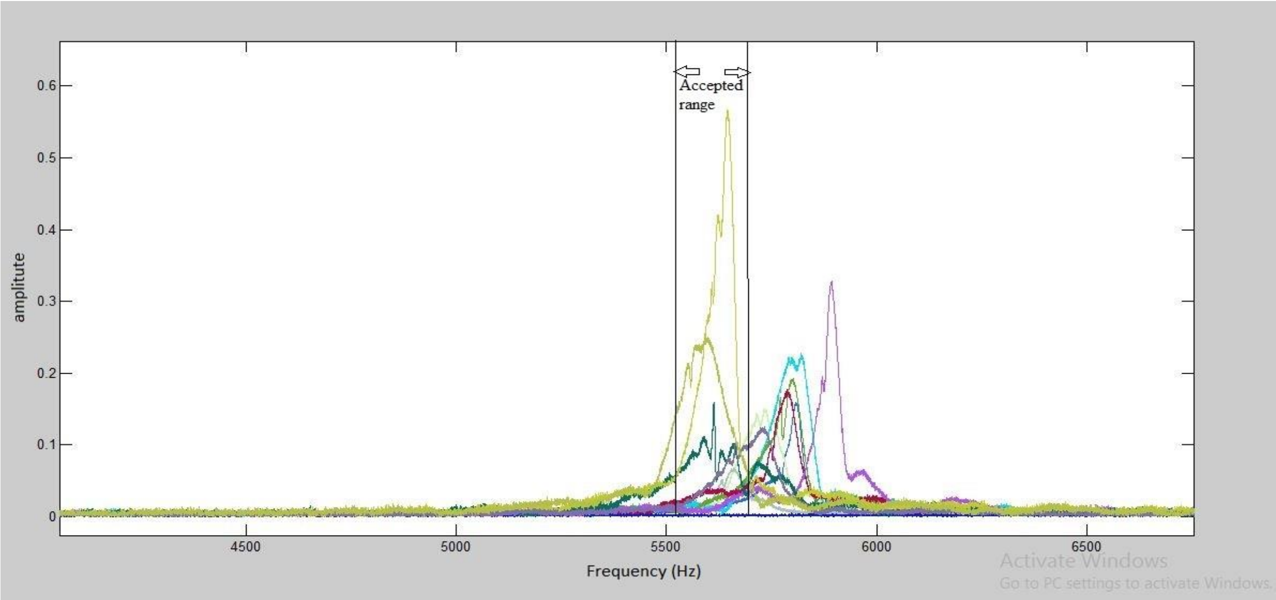
Program is based on the comparison of standard frequency and actual frequency practically no casting has same signal. So acceptable limits are given to sort out the defected and accepted casting. Following is the algorithm shown in fig.

When algorithm starts it starts the conveyor if casting is detected conveyor stops moving and then casting is excited by solenoid then signal is received and it is compared with standard casting signal if that signal is in acceptable limit then it is given as accepted and when it is not in limit it is rejected.

V. RESULTS



(a)



(b)

Graph: Above Graphs Shows the Deviation of Defective from Standard Casting

Above graphs are obtained from MATLAB. Graph (a) is for total sound frequencies those are capture by the microphone. Whereas graph (b) is magnified version of graph (a) for better understanding in the various cause due to the defect present in the casting. Even two defect free casting can't be identical therefore, there is some tolerance or acceptable frequency band. The width of frequency band is depending upon the acceptable defects and the variation in graph due to that defects.

The same technique can be improved by using more accurate and highly sensitive microphone to enhance the result up to the level of detecting the position, the size and the depth of defect. The computerized system can make it easy to record data such as type of defect and their occurrence and this data can be further analysis and conclusion may be drawn based on that.

VI. Advantages

Following are some advantages of the casting inspection technique

i. Labour less work: Inspection of casting defect by human involves more manpower and is also prone to more errors as human element is involved. By using automated inspection system labour work will be reduced.
ii. More accurate results: Inspection of casting defects by human is limited as it is tedious, tiredness work.
iii. More operational speed: as time required to process the signal is less as compared to ultrasonic inspection of casting defect.
iv. Cost effective: Cost involved in automated casting inspection is less as compared to inspection by ultrasonic inspection for large foundries.
v. Less delivery time: As time required in inspecting casting by acoustic technique is less as compared to ultrasonic and hence the remaining manufacturing operations can be carried out and part is dispatched to market in less time.

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