

HSE Assessment and Improvement in Shot Blasting Process

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Abstract: In foundry industry the shot blasting process plays a vital role for clean, strengthen or polish the metal, in foundries the handling of shot blasting machines having most hazards related to health, safety & Environment are involved. It may cause eye, skin and respiratory tract irritation to health. Particularly in aluminium foundries the aluminium dust emission product is a white crystalline powder and it has the characteristics of forming explosive dust in the air mixtures. In this dust emission the acute effects are health hazards; particulates may cause irritation to the eyes, nose, throat and lungs. In case of inhalation by the operators and co-workers it may be irritating to the respiratory tract and cause respiratory disorder. In case of chronic effects it may leads to lung cancer and the risk of severe effects depends on duration and level of exposure. The route of entry is inhalation, skin and eye contact and the affected target organs are respiratory system, lungs. Skin & eyes. The unusual fire & explosion hazards are dust in high concentrations may form explosive mixtures with air. The hazardous combustion products are listed as irritating gases, vapors, fumes and oxides of carbon. This project is to reduce the risk level by implementing the assessment and improvement control measures in the shot blasting machines by effective qualitative analysis method.

Keywords: Shot Blasting, Hazards, Emission, Exposure, Health Effects.

I. Introduction

Aluminium Die casting is a metal casting process that is characterized by forcing molten metal under high pressure into a mold cavity. The mold cavity is created using two hardened tool steel dies which has been machined into shape and work similarly to an injection mold during the process

The casting equipment and the metal dies represent large capital costs and this tends to limit the process to high volume production. Manufacture of parts using die casting is relatively simple, involving only four main steps, which keeps the incremental cost per item low. It is especially suited for a large quantity of small to medium-sized castings, which is why die casting produces more castings than any other casting process. Die castings are characterized by a very good surface finish (by casting standards) and dimensional consistency.

The aluminium dust explosion overpressure will be vented out using a relief vent system [18]. The musculoskeletal disorder among the foundry workers and this cause the symptoms due to highly repetitive work, forceful exertions, lifting and forceful movements, and whole-body vibration are examples of risk factors that have been associated with increased the reporting of WRMSDs.[13]. The exposure to continuous noise leads to hearing loss. Noise has to be classify the effects on ears in three groups which are acoustic trauma, temporary hearing losses and permanent hearing loss.[7].The erosion rates of these ceramic nozzles also depend on the hardness and grain size of the erodent abrasive in sand blasting processes[6]. In the aluminium die casting industry it is a source of metal emissions to the environment that may be toxic to humans and other organisms. Moreover, the industry emits air pollutants, such as nitrogen oxides and carbon dioxide, which cause troposphere ozone formation, acidification, human toxicity and global warming [3].

II. Hazards In Shot Blasting Process

Aluminium Dust Emission:

The aluminium dust emission is very dangerous and is explosive while it get ignited and also made some occupational related health issues occur due to inhale the dust.

Musculoskeletal Problem Due To Handling Of Vibrating Tool Or Part

By handling of the vibration tool for a prolonged period cause musculoskeletal problems to the worker

Dust Inhalation

Dust inhalation may cause adverse health effects to the workers.

Noise:

Evaluation by occupational health and safety personnel of noise should be undertaken to identify areas where noise levels may be excessive. Surveys of foundries have shown that the fettling and shakeout operations give rise to considerable noise levels, with potentially harmful effects on the hearing of exposed workers. In

addition to the workers immediately involved in these processes, people working in the vicinity may be exposed to noise levels well in excess of 85 db (A).

Some fettling workers have been shown to be exposed to levels of noise over 100 db(A); shakeout and knockout processes are typically associated with readings of 90-110 db(A).Extraction fans, die casting machines, shot blasting machines and shell making equipment may also be a sources of excessive noise

Vibration:

Pneumatic grinding and chipping tools used in dressing the cooled castings may cause vibration induced health effects in operators. Potentially hazardous vibration equipment may also be utilized in shakeout and core removal operation. Holding the compressor air hose for aluminium oxide shot blast also induced vibration to the worker.

Leakage In Shots:

At the time of blasting the metal the leakage of shot is a major hazard in the shot blasting machines

Heat Radiation

Radiant heat is the major contributor to the heat load imposed on the worker by the environment. Convective heat transfer adds to this heat radiant. Protective clothing is worn for protection against the heat radiating from the heat sources and against contact with molten metal. Such clothing greatly restricts the potential for body heats loss via evaporation. The foundry worker experiences a total heat load which is determined by the time spent at each workstation, the intensity of the work, the clothing worn and the immediate workstation environment, including air circulation. If the heat load is sufficiently severe, the effects on health and the performance will occur. These range from decreased concentration to painful cramps, fainting, heat exhaustion and heat stroke.

Physical Injuries:

Serious burns may result from splashes of molten metal in the melting and pouring areas of the foundries. Frequent, unprotected viewing of white hot metals in furnaces and pouring areas may cause eye cataracts. Eye injuries from molten metal or fragments of metal may occur in the pouring and dressing areas.

During continuous casting process, non ferrous molten metal's, such as copper, aluminium, may explode violently if they contact with water. Such explosions can occur in water cooled furnaces. Whenever the spillages of molten metal occur during the charging of furnaces with wet ingots or scrap metal and whenever the moist tools, moulds or other material come into contact with molten metal. Injuries related to manual handling of materials and injuries due to slip may occur.

Noise Reduction

The detection of noise emitted from the machine was to examine by the noise level meter and compare it with the previous measurements. The noise level considered in this experiment ranges from 85db to 105db. It has to be reduced by means of proper engineering judgement. The noise exposure was minimised by insisting the PPE among the machine operators and co- workers those are employed in the machine area.

III. Ppe Used To Reduce Noise

Ear Plug

Ear plug is insisted to the workers to minimise the noise exposure emitted from the shot blasting process and the given PPE is conforming to IS (Indian Standard) 6229:1971 were used. The typical noise level is listed in Table 3.1

Table 3.1 Typical Noise Level

Location	dB
Machine Shop	90
Manufacturing	80
Assembly Line	75
Office	55

Blast Nozzle – Shot Blast

Locally available blast nozzle was replaced and conforming to IS 383:1970 were used. The nozzle has to be replaced if the bore has increased 25% or more. The nozzle size and its efficiencies are listed in Table 3.2

Table 3.2 Properties of Aggregate

	Nozzle size	Nozzle pressure			
		50 Psi	90 Psi	100 psi	120 psi
No.2	1/8"	14	24	26	30
No.3	3/16"	32	52	57	67
No.4	1/4"	57	93	103	119
No.5	5/16"	89	145	158	186
No.6	3/8"	129	209	229	269
No.7	7/16"	176	285	312	367
No.8	1/2"	229	371	407	478
No.10	5/8"	356	580	632	744
No.12	3/4"	516	836	916	1076
Efficiency		47%	86%	100%	130%

Acoustic Rubber Liner

Acoustic thick wear resistant rubber liner sheet were used to ensure the noise reduction and ensure the long life of shot blasting chambers. The properties of Acoustic rubber liner sheet is listed in Table 3.3

Table 3.3 Properties of Acoustic rubber liner sheet

S.no	Properties	Values
1	Length	(1000*2000*6) mm
2	Material	CR
3	Hardness	65
4	Density	1.4 g/cm ³
5	Color	Black
6	Tensile Strength	60 kg/cm ³
7	Elongation at break(%),min	250

IV. Dust Emission Reduction

Hoods and dust collecting bins are properly fitted in position to collect all the travelling dust and remove all the leakage dust in regular basis.

Respirator and goggles are insisted those who are working near the machine area. The emission dust is flammable if it catches ignition causes fire/explosion. Explosion vent to be provided and regularly the dust to be removed.

Flame proof electrical connection to be provided and ensure double earthing for electrical connection. Static dissipater to be provided to eliminate the static discharge.

Shot Leakage Reduction

The shot blasting chamber has to be maintained properly in a regular frequency and it has to be ensured that the chamber is checked by a competent person to ensure its stability.

V. Wrmsd

The castings are handled manually by operator for blasting operation; continuously they are doing the repeated job leads to work related muscular skeletal disorder. It has to be minimised by implementing the job rotation to the operator and provide proper rest pauses.

Repeated ergonomics training provided to the operator and ensure that they were followed the proper working posture at work time has to be noted by behavioural analysis.

VI. Heat Reduction

The heat radiation has to be controlled by providing hoods and the temperature to be monitored on regularly by dry bulb and wet bulb method to ensure the heat radiation is under normal condition.

VII. Machine Check Points

The machine has to be checked on regular basis with the following check points. The check points are listed in table 3.4.

Table 3.4 Check Points

S.No	Check points	YES	NO	Remarks
1	Explosion Vent			
2	Exhaust Provision			
3	Shot Leakage			

4	Maintenance of dust Pit			
5	Gauntlets Availability			
6	Double Earthing			
7	Manometer availability			
8	Nozzle & Blast hose Condition			
9	Foot pedal / Operator platform			
10	Vision window condition			
11	Guarding Arrangement			
12	Emergency Push button			
13	ON/OFF Switch Condition			
14	Area Lighting			
15	Ventilation			
16	Noise Level			
17	Access/Egress Condition			
18	PPE Insisted & Worn			
19	Rubber Liner Condition			

From the table 3.4, the check points to be checked and ensure the machine was in good condition.

VIII. Noise Level

Initial Vs Implementation

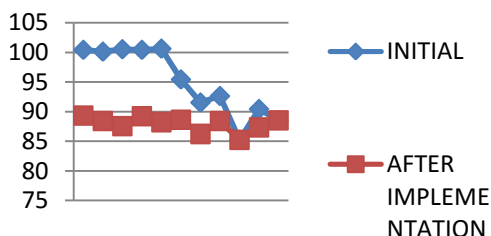


Table 3.5 Noise level Initial vs Implementation

Location	Initial	After Implementation
1	100.4	89.3
2	100.1	88.4
3	100.5	87.5
4	100.4	89.2
5	100.6	88.2
6	95.4	88.6
7	91.5	86.2
8	92.6	88.4
9	85.2	85.2
10	90.4	87.3
11	88.5	88.5

Figure: Noise level Initial vs Implementation

IX. Result

- Regular inspection and maintenance showed that the stability of the machine and ensure that it is free from defects.
- Noise study also showed that there was decrease in dB when compared with the initial dB after implement the remedies.
- When compared with behavioral observation among the operators, the training needs to be identified and provided to improve the safety culture.
- The initial noise level showed that some area are under critical situations and need importance to the location it has to be minimized through engineering suggestion
- Training needs to be provided to improve the safety awareness among the operators and co-workers those who are worked in that machine area.
- The usage of PPE also reduced the exposure from dust & noise emitted from the shot blasting process.

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