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# Sand Blasting Of Inlet And Exhaust Valves In Diesel Alco Locomotive's Cylinder Head

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***Abstract***
*In the diesel locomotive during combustion process the carbon deposits on the surfaces of the engine components. The removal of carbon from the components is a very tedious process. Most of the time the carbon deposition will lead to replacement of that component.It requires huge amount for the new component. To overcome this problem sand blasting technique can be used. This method will be very useful for cleaning or removing the carbon deposits. By this method the components can be reused. It will save the cost.*
***Key Words:*** *Sand blasting, valves, cylinder head, carbon deposits.*

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## I. INTRODUCTION

Inlet and exhaust valve role is controlling the flow of gases in the diesel engine. Primarily the direction of flow. As the names would suggest, the intake valve controls whether material is allowed to flow into the chamber. The inlet valves seal the intake port, through which the air flows into the combustion chamber. The exhaust valve controls whether material is allowed to flow out of the chamber. Exhaust valve control the flow of combustion gases and let the stream out after the combustion cycle. The inlet valve is bigger one when compared to the exhaust valve. The main reason for the size difference is to avoid pre-ignition and knocking. The exhaust valve is the hottest part of the engine. The valves in the Alco loco diesel engines are made up of forged nickel chromium alloy.

**VALVE DETAILS:**

The valve seat inserts are ground to an angle of44.5° whereas the valve is ground to 45° to ensure line contact. (In the latest engines the inlet valves are ground at 30° and seats are ground at 29.5°). Each cylinder has 2 exhaust and 2 inlet valves of 2.85" in dia. The valves have stem of alloy steel and valve head of austenitic stainless steel, butt-welded together into a composite unit. The valve head material being austenitic steel has high level of stretch resistance and is capable of hardening above Rockwell –34 to resist deformation due to continuous pounding action. The valve guides are interference fit to the cylinder head with an interference of 0.0008" to 0.0018". After attention to the cylinder heads the same is hydraulically tested at 70 psi and 190°F. The fitment of cylinder heads is done in ALCO engines with a torque value of 550 Ft.lbs. The cylinder head is a metal-to-metal joint on to cylinder.

## II. LITERATURE SURVEY

Snehal S.Gawale et al[1] proposed poor designing of exhuast valve leads to the failure of the exhaust valve before its expected working hours. M Panțuru et al [2] conducted the experiment on the internal combustion engine and found the wear affecting the exhaust valve and inlet valve. Chowdavaram Sai Prasad et al[3] suggested the thermal aspect required for designing the exhaust valve. V. Mallikarjuna et al[4] proposed a best method of joining the exhaust valve by head pin friction instead of pin pin friction. D.Rengadurai et al[5] concluded painting the exhuat valve to increase the life hours sand blasting is most appropriate method. Shikha parashar et al [6] suggested the sandblasting is best method of removing dirt and rust from the surface.

## III. ALCO LOCO

The ALCO DL560C is a passenger/freight-hauling diesel-electric locomotive with AC electric transmission designed by the American Locomotive Company and produced under license by Diesel LocomotiveWorks (DLW) Varanasi, India for Indian Railways as their classes WDM-2, WDM-3A/2C, WDM-3D and WDG-3A for operation in India. The locomotive is fitted with a 16-cylinder ALCO 251 B,C diesel engine. In the early 1960s Indian Railways needed a reliable diesel workhorse to gradually replace its steam

locomotive fleet. Equal numbers (40 each) of ALCO's DL560C and EMD's SD24 were chosen for trials. More locomotives of each of these were purchased for more trials. Indian Railways was keen on producing these locomotives in the country rather than depending on imports. EMD did not agree for a Transfer-of-Technology, while ALCO did. Thus ALCO DL560C was chosen for the job due to its easy maintenance, reliability and simple operation. And from then on vast numbers of this loco in different configurations have been produced and they still continue to dominate the diesel route of Indian Railways.

**3.1 Types of ALCO LOCO**

**WDM-2:**

The first loco of the type DL560C to arrive in India is WDM-2. Initial batches arrived from the ALCO manufacturing facility in ready-to-ride condition. And 12 more arrived from ALCO in, to be assembled kits. This loco remained as the workhorse of Indian Railways in the 20th century. This loco solely can haul 9 passengers and can haul 18 with the help of another WDM-2. This model had a maintenance schedule of 3000 km/10days. Later on, improving the fluid level and bearings, the schedule was increased to 30 days. The gear ratio being 65:18 and having a max speed of 120 km/h. JUMBOS (full-width short hood) and WDM-2A/2B are some of WDM-2s variants with minor modifications. The production began in the late 1960s, and went on till the late1990s. They are being eventually retired. They belong to series 18xxx, 17xxx and 16xxx.

**WDM-3A/2C:**

WDM-3A, previously known as WDM-2C, is more powerful than the previous WDM-2 version by 500 hp. The first loco was delivered in 1994. This loco was capable of doing the work of two WDM-2S. They too had a top speed of 120 km/h. The gear ratio is same as that of WDM-2. There are some locomotives whose maximum hp has been tuned close to 3900 hp and named as WDM-3A. They are still under production. WDM-3C is an upgraded loco from its previous WDM-3A. Their series is 14xxx.

**WDM-3D:**

This is the latest and the most advanced variant of all the available ALCOs. The WDM-3D is fitted with micro-processors. This variant has enhanced cabin facilities including left hand driving. This loco also has some features borrowed from its mate EMD GT46PAC. Features such as microprocessors to detect wheel slipping and phased manner power supply, monitoring engine parameters are incorporated from the latest EMD GT46PAC. This proved this variant a real success. Serial production began in 2005 and almost all diesel broad gauge sheds were allotted with this loco. The minor variants of this loco include WDM–3E and WDM–3F. They belong to series 11xxx.

**WDG-3A:**

WDG-3A, previously known as WDG-2 was designed owing to the problems which arose with WDM-2 on hauling freight. This loco normally hauls freight. The common problems were poor ride quality, lateral oscillations, and poor traction with heavy loads. First loco was manufactured in 1995. The gear ratio is 74:18. This loco has a balancing speed of 69 km/h with a load of 58 BOXN wagons (Max. speed 100 km/h). This variant is being gradually modernized to the level of WDM-3Ds. Some of its minor improvements include WDG-3B, WDG-3C and WDG-3D. Their series are in 14501-14999 and 13000-13665. Last one built for Indian Railway was 13665 rolled out in 2012. Total 1171 were built for Indian Railways and a considerable number were supplied to Non Railway customers like thermal power plants, port trusts and steel plants.

**3.2 Major components of Alco Loco:**

The Diesel engines consists of following major components & assemblies: -

1. Engine base
2. Engine block
3. Crankshaft
4. Cam shaft
5. Cylinder headand Valves
6. Liner
7. Piston, Piston rings andConnecting rods.

## IV. CYLINDER HEAD

The cylinder head is held on to the cylinder liner by seven hold down studs orbolts provided on the cylinder block. It is subjected to high shock stress and combustiontemperature at the lower face, which forms a part of combustion chamber. It is acomplicated casting where cooling passages are cored for holding water for cooling thecylinder head. In addition to this, provision is made for providing passage of inlet air andexhaust gas. Further, space has been provided for holding fuel injection nozzles, throughNozzle Sleeve fitted in the cylinder head. Valve guides and valve seat inserts also fitted inthe cylinder head casted body.

In cylinder heads valve seat inserts with lock rings are used as replaceable wearing part.

The inserts are made of stellite or weltite. To provide interference fit, inserts are frozen inice and cylinder head is heated to bring about a temperature differential of 250°F and theinsert is pushed into recess in cylinder head. The valve seat inserts are ground to an angleof 44.5° whereas the valve is ground to 45° to ensure line contact. (In the latest engines theinlet valves are ground at 30° and seats are ground at 29.5°). Each cylinder has 2 exhaustand 2 inlet valves of 2.85" in dia. The valves have stem of alloy steel and valve head ofaustenitic stainless steel, butt-welded together into a composite unit. The valve headmaterial being austenitic steel has high level of stretch resistance and is capable ofhardening above Rockwell –34 to resist deformation due to continuous pounding action.

The valve guides are interference fit to the cylinder head with an interference of 0.0008"to 0.0018". After attention to the cylinder heads the same is hydraulically tested at 70 psiand 190°F. The fitment of cylinder heads is done in ALCO engines with a torque value of550 Ft.lbs. The cylinder head is a metal-to-metal joint on to cylinder.

The cylinder head castings are made from special alloy cast iron as per specification givenbelow:

**Material composition:**

Total carbon: 3.00 to 3.40%
Silicon: 1.80 to 2.20%.
Sulphur: 0.12% to 0.8%.
Phosphorous: 0.15 Max..
Manganese: 0.65% to 90%
Chromium: 0.20% to 0.40%
Nickel: 1% Min.
Molybdenum: 0.35% to 0.45%

ALCO 251+ cylinder heads are the latest generation cylinder heads, used in updatedengines, with the following feature:

(i) Fire deck thickness reduced for better heat transmission.

(ii) Middle deck modified by increasing number of ribs (supports) to increaseits mechanical strength. The flying buttress fashion of middle deckimproves the flow pattern of water eliminating water stagnation at thecorners inside cylinder head.

(iii) Water holding capacity increased by increasing number of cores (14instead of 11).

(iv) Use of frost core plugs instead of threaded plugs, arrest tendency ofleakage.

(v) Made lighter by 8 kgs (Al spacer is used to make good the gap betweenrubber grommet and cylinder head.)

(vi) Retaining rings of valve seat inserts eliminated.

**Benefits:**

1. Better heat dissipation

Failure reduced by reducing crack and eliminating sagging effect of firedeck area

## V. CARBONIZATION IN CYLINDER HEAD

### 5.1 Carbonization in Cylinder Head:

Due to the combustion process that takes place inside the engine, various products such as carbon get deposited on the surface of cylinder head and on its inlet and exhaust valves.The carbon particles get deposited over the components.So it will lead to reduction in efficiency of the engine.The image shows the carbon deposited on the inlet and exhaust valves of cylinder head in ALCO locomotives.

**5.2 Decarbonising Using Sand Blasting Technique:**

For removing the carbon particles that are deposited on the valve's surface we have used sand blasting technique.

Sand blasting , also known as abrasive blasting ,is a technique in which fine sand is used as abrasive and air as abrasive medium is used to blast over the desired part so that it can be cleaned.

## VI. METHODOLOGY

### 6.1 Sand Blasting:

Sand blasting is also known as abrasive blasting, which is a generic term for the process of smoothing, shaping and cleaning a hard surface by forcing solid particles across that surface at high speeds; the effect is similar to that of using sandpaper, but provides a more even finish with no problems at corners or crannies. Sandblasting can occurartificially, using compressed air. An artificial sandblasting process was patented by Benjamin Chew Tilghman on 18 October 1870.Sandblasting equipment typically consists of a chamber in which sand and air are mixed. The mixture travels through a hand-held nozzle to direct the particles toward the surface or work piece. Nozzles come in a variety of shapes, sizes, and materials. Boron carbide is a popular material for nozzles because it resists abrasive wear well.

### 6.2 Sand Blasting Machine:

The machine which is used for carrying out sand blasting process is known as sand blasting machine.Sand blasting machine clean rough surfaces by abrasion them with sand. It fires sand out of an air-powered pressure gun at high velocity. When compressed air flows through the hose, it creates pressure which pulls sand from a tank through the sand blast gun. It also refines a surface and giving a decorative finish to craft metals. It can be used to remove old paint, smooth a rough surface, and roughen a smooth surface, cleaning rust formation and impurities in metal surface. The sand blasting machine replaces the use of sandpaper, eliminating the need for hand-sanding, grinding and the mess goes along with it. Sand blasting machine is quick, efficient and delivers desirable results.

### 6.3Components of Sand Blasting Machine:

The sand blasting machine consists of various components in it they are:

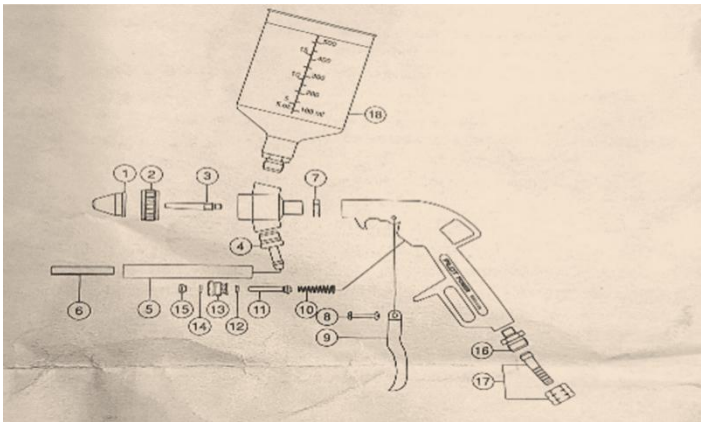
**1. Compressor:**

An air compressor is a device that converts power into potential energy stored in pressurized air (i.e., compressed air). By one of several methods, an air compressor forces more and more air into a storage tank, increasing the pressure. When tank pressure reaches its engineered upper limit, the air compressor shuts off. The compressed air then is held in the tank until called into use. The energy contained in the compressed air can be used for a variety of applications, utilizing the kinetic energy of the air as it is released and the tank depressurizes. When tank pressure reaches its lower limit, the air compressor turns on again and re-pressurizes the tank. An air compressor must be differentiated from a pump because it works for any gas/air, while pumps work on a liquid.


**2.Sand Blast Gun:**

A pressure blaster consists of a larger container filled with fine sand that's under high pressure. This tool applies a concept similar to that of an aerosol can. A special hose connects to a port that is located at the bottom of the gun and attaches the container to the sandblasting gun. The nozzle is used to speed up and direct a flow the mixture of abrasive.

| Specification | Range |
|---|---|
| Air Consumption | Approx 220 I/min |
| Working Pressure | Max.7.0 bar |
| Blasting Nozzle | Dia 4mm |
| Blast Media (Grain Size) | 0.2-0.8 mm |
| Weight | 500 gms |
| Recommend inner air hose diameter | 9mm |
| Pressurized air required | Clean and oil free |
| Recommended working pressure | Max. Working pressure set at regulator or filter/pressure regulator max.7 bar |



**Sand Blasting Gun Description**

| | |
|---|---|
| 1 | Nozzle |
| 2 | Nozzle locking nut |
| 3 | Fluid air nipple |
| 4 | Connection nipple |
| 5 | Plastic suction tube |
| 6 | Metal suction tube |
| 7 | Hd. Ret. Screw locking nut |
| 8 | Trigger screw |
| 9 | Trigger |
| 10 | S.S. Spring for air valve pin |
| 11 | Air valve pin with nut |
| 12 | Rubber washer |
| 13 | Air valve body |
| 14 | Packing |
| 15 | Air valve packing nut |
| 16 | Air intake connector |
| 17 | Hose coupling |
| 18 | Nylon top feed cup 0.57 litre |

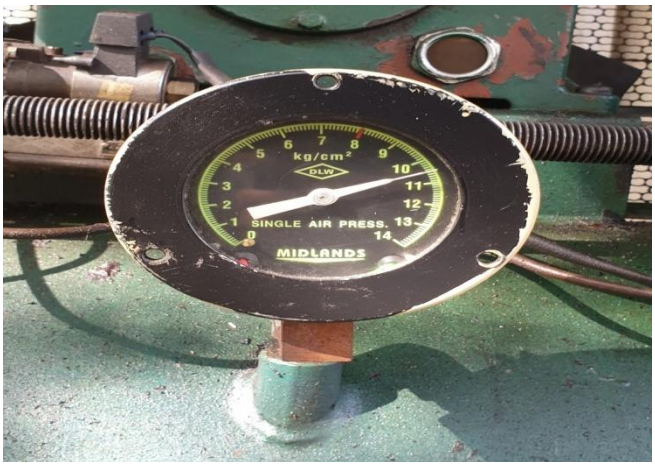
**3.Air Filter:**

A particulate air filter is a device composed of fibrous or porous materials which removes solid particulates such as dust, pollen, mould, and bacteria from the air. The Air Filter is fitted near the air compressor. The air is filtered out by sending the air through the filter and then compressor is switched OFF. Then the air filter is drained out by taking out and cleaning the filter. Now the filter is fitted again and compressor is switched ON. The air flowing to the mixture chamber is now with no moisture content.

**4.Mixing Chamber:**

A volume or space in a mixing of substances may occur specifically, a vessel, stationary or revolving, in which the sand and airtogether form a mixture for
sand blasting

**4.Pressure Gauge:**




**5.Cut Out Cock:**

A cut out cock is a valve used to control fluid flow by varying the size of the flow passage as directed by a signal from a controller. This enables the direct control of flow rate and the consequential control of process quantities such as pressure, temperature, and liquid level.

**6.Blast Cabinet:**

A blast cabinet is essentially a closed loop system that allows the operator to blast the part and recycle the abrasive. It usually consists of four components; the containment (cabinet), the abrasive blasting system, the abrasive recycling system and the dust collection. The operator blasts the parts from the outside of the cabinet by placing his arms in gloves attached to glove holes on the cabinet, viewing the part through a view window, turning the blast on and off using a foot pedal or treadle.

**Exterior**

**Interior**

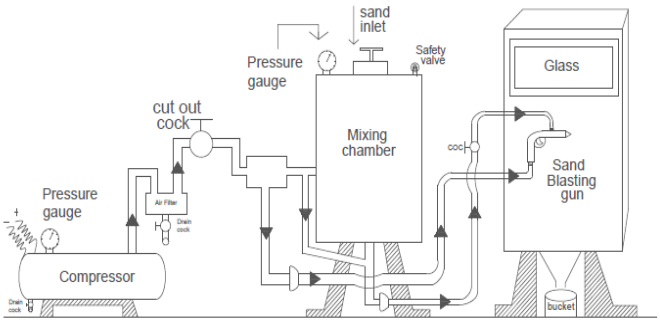
**7.Safety Valve:**

The primary purpose of a safety valve is the protection of life, property and environment. A safety valve is designed to open and relieve excess pressure from vessels or equipment and to reclose and prevent the further release of fluid after normal conditions have been restored.

Range = 8 to 10 kg/cm$^2$

After obtaining this range the safety valve will automatically open.

## VII. SCHEMATIC EPRESENTATION OF SAND BLASTING PROCESS




## VIII. WORKING

In this process, sand is usedas abrasive and air is used as abrasive medium. An air compressor is usedfor producing Compressed air of pressure 6-8 kg/cm². A pressure gauge is fitted in theair compressor to monitor the air pressure. To drain exist air from compressor, a draincock is fitted below the Compressor.When compressor is switched ON, air enters the air filter,the moisture content in compressed air is filtered out and

then the compressor is switched OFF, air filter is drained out usingdrain cock fitted in the air filter. Now Compressor is switched ON,so air with no moisture content flows through the air filter.Then air enters the mixing chamber through Cut out Cock (COC). One stream of air enters into the mixingchamber and mixes with the sand while another stream of air enters to the sand blasting gun directly on its one end. Sand filled inside the mixing chamber thorough Sand inlet.A pressure gauge is present in the mixing chamber to monitor the air pressure inside the chamber, if air pressure exceeds 8 kg/cm², safety valve will automatically open. The air and sand mixture flows to the sand inlet of sand blast gun with help of cut out cock. The valves are cleaned using the sand blasting gun by spraying the air-sand mixture of high pressure in blast cabinet. This process can be seen through the glass fitted on the top of the blast cabinet. The sand which is used to clean is collected using a bucket which can be reused again by filtering it.

**8.1 Grinding**

Every valve in the cylinder head is replaced due to the carbon deposition but we can reuse the valve by sand blasting technique. After this process the valves are grinded because the diameter of the valve should not less than 2mm.

## IX. ADVANTAGES OF SAND BLASTING

i. Corrosion particles will be removed,
ii. Carbon particles will be removed,
iii. Interior parts can also be cleaned by using sand blasting process,
iv. Life of the components will not get affected, It increase the component life,
v. It is a quick cleaning process,
vi. It has a wide range of applications in the cleaning process,
vii. This process convertsthe old components into a new component,
viii. Theaccuracy of sand blasting process is very high when compared to other process,
ix. This process reduce the work time ,
x. Itreduces the component replacement cost.

## X. CONCLUSION

Thus, Sand blasting process is an efficient way for removing carbon deposits in engine components. Removing of carbon deposits in engine components results in reuse of parts and thus there will be no requirement for the purchase of new parts which is economically feasible. It is more economical process when compared to other processes. The accuracy of sand blasting process is very high when compared to other process.

If sandblasting process is used extensively as a method to clean the engine components, then procurement of new parts is avoided which results in reduced cost and more efficiency. Since the process involves only less initial cost, it is easy to setup sandblasting assembly in industries and thereby old parts can be reused by performing sandblasting method of cleaning.

Although sandblasting process is considered as a unsafe process worldwide,it can be made as a safe and successful process by adopting precautionary measures and rules

Sandblasting process has a high scope in future engineering trends since the engineering world is moving upon sustained growth by using regenerative methods. Industries are in search of methods to reuse the used parts to avoid the glut of old parts and to avoid the cost in producing new parts instead of the old ones. So, if sandblasting is brought as a method for reusing the old parts it will be a successful process in the engineering field.

Sandblasting process is a versatile and well understood process. Process refinements over time have helped to make sand blasting a process of choice for applying it in industrial markets. Sand blasting process can be used for aesthetic reasons which help in improving the surface layer of the treated component.

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