EXPRESSOR

(6 CD, 4 UC COMPRESSOR EXHAUSTER)

Objective

- To learn the requirement of expressor in locomotive.
- To learn the function of exhauster.
- To learn the function of compressor.
- To learn the loading-unloading arrangement of compressor.
- To learn the function of air governor.

Structure

• INTRODUCTION

In Indian Railways, the trains normally work on vacuum brakes and the diesel locos on air brakes. As such provision has been made on every diesel loco for both vacuum and compressed air for operation of the system as a combination brake system for simultaneous application on locomotive and train.

In ALCO locos the exhauster and the compressor are combined into one unit and it is known as EXPRESSOR. It creates 22" of vacuum in the train pipe and 140 PSI air pressure in the reservoir for operating the brake system and use in the control system etc.

The expressor is located at the free end of the egine block and driven through the extension shaft attached to the engine crank shaft. The two are coupled together by splined flexible coupling (Kopper's coupling). Naturally the expressor crank shaft has eight speeds like the engine crank shaft and runs between 400 RPM to 1000 RPM range.

• CONSTRUCTION AND DESCRIPTION

The expressor consists of the following components mainly;

(1) Crank case (2) Crank shaft (3) Four Nos. of exhauster cylinders with cylinder heads (4) One low pressure compressor cylinder with cylinder head (5) One high pressure cylinder with cylinder head (6) Six nos. of pistons with connecting rods (including one LP, one HP and four exhauster). (7) Lube oil pump.

Each of two crank journals support three connecting rods. The crankshaft is supported at the both ends by double row ball bearings. Outside the ball bearings are located oil seals to prevent the leakage of oil from inside the crank case and air from out side into it.

The specific features and data are given below:-

Details	Compressor (LP)	Compressor (HP)	Exhauster
1. No. of cylinders	1	1	4
2. Cylinder bore	7.750"	4.250"	7.250"
3. Stroke	5.625"	5.625"	5.265"
4. Piston rings (Comp. & oil scrapper)	2+2	2+2	2+2

5. Normal working pressure – 140 PSI or 10 Kg/cm.sq.

6. Rated speed – 1000 RPM

7. Compressor displacement – 153.5 CFM / 4350 LPM at rated speed.
61.4 CFM / 17400 LPM at rated
Idle speed.

8. Exhauster displacement – 614 CFM / 17400 LPM at rated speed.
246 CFM / 6960 LPM at idling.

9. H.P consumed – **115** H.P max.

10. Lube oil pressure – 25 PSI to 60 PSI.

11. Oil sump capacity – 21 Lts.

12. Weight in assembled condition – 982 Kg.

- **WORKING OF EXHAUSTER**

Air from vacuum train pipe is drawn into the exhauster cylinders through the open inlet valves in the cylinder heads during its suction stroke. Each of the exhauster cylinders has one or two inlet valves and two discharge valves in the cylinder head. A study of the inlet and discharge valves as given in a separate diagram would indicate that individual components like (1) plate valve outer (2) plate valve inner (3) spring outer (4) spring inner etc. are all interchangeable parts. Only basic difference is that they are arranged in the reverse manner in the valve assemblies, which may also have different size and shape. The retainer stud in both the assemblies must project upward to avoid hitting the piston.

The pressure differential between the available pressure in the vacuum train pipe and inside the exhauster cylinder opens the inlet valve and air is drawn into the cylinder from train pipe during suction stroke. In the next stroke of the piston the air is compressed and forced out through the discharge valve while the inlet valve remains closed. The differential air pressure also automatically open or close the discharge valves, the same way as the inlet valves operate. This process of suction of air from the train pipe continues to create required amount of vacuum and discharge the same air to atmosphere. The VA-1 control valve helps in maintaining the vacuum to requisite level despite continued working of the exhauster.

- **COMPRESSOR**

The compressor is a two-stage compressor with one low-pressure cylinder and one high-pressure cylinder. During the first stage of compression it is done in the low-pressure cylinder where suction is through a wire mesh filter. After compression in the LP cylinder air is

delivered into the discharge manifold at a pressure of 30 / 35 PSI. Working of the inlet and exhaust valves is similar to that of exhauster that automatically open or close under differential air pressure. For inter-cooling air is then passed through a radiator known as inter-cooler. This is an air to air cooler where compressed air passes through the element tubes and cool atmospheric air is blown on the out side fins by a fan fitted on the expressor crank shaft. Cooling of air at this stage increases the volumetric efficiency of air before it enters the high- pressure cylinder. A safety valve known as inter cooler safety valve set at 60 PSI is provided after the inter cooler as a protection against high pressure developing in the after cooler due to defect of valves.

After the first stage of compression and after-cooling the air is again compressed in a cylinder of smaller diameter to increase the pressure to **135-140** PSI in the same way. This is the second stage of compression in the HP cylinder. Air again needs cooling before it is finally sent to the air reservoir and this is done while the air passes through a set of coiled tubes below the loco superstructure.

- **LOADING AND UNLOADING OF COMPRESSOR**

To avoid the compressor running hot due to overloading and also to avoid the wastage of engine horsepower, arrangements are provided to unload the compressor when a particular pressure is reached. In other words the compessor cylinders are not required to compress air any further when the main reservoir pressure reaches 10 kg/sq.cm. So the compressor stops loading the main reservoir. Due to no further compression being done, reservoir pressure naturally falls due to normal consumption and leakages. When the M.R. pressure comes down to 8 kg/sq.cm., the compressor resumes loading of the M.R. again.

Basically in these compressors the unloader plunger prongs, effect unloading by pressing down the inlet valves of both L.P. & H.P. cylinders to keep them in open position, as soon as 10kg pressure is reached in the M.R. It continues to be so till the pressure comes down to 8 kg/sq.cm. Thus the compressor remains unloaded or relieved of load in the range between 10 to 8 kg/sq.cm. M.R.

pressure. In this case, the L.P. cylinder air drawn in through the intake filter is thrown out in the same direction. In case of the H.P. cylinder air is pushed back to the inter cooler and L.P. discharge manifold. This is achieved through the function of the unloader plunger in conjunction with the air governor.

- **NS – 16 AIR GOVERNOR**

The function of the air governor is to transmit main air reservoir pressure to the top of unloader plunger as soon as the MR pressure reaches 10 kg/sq.cm. With the fall of pressure to 8kg. the same supply is discontinued and existing pressure in the unloader valve is vented out. This action keep the suction valve open when loading of MR is not required any more and again allow the compressor to work normally for loading when needed.

The NS-16 air governor consists of governor body in two pieces of bronze castings and a pipe bracket with a number of air passages. It also incorporates (1) wire mesh filter (2) cut out cock (3) cut out adjusting stem (4) cut out valve spring (5) cut out valve spring adjusting nut (6) cut in tail valve (7) cut in valve (8) cut in valve adjusting stem (9) cut in valve spring (10) cut in valve adjusting nut.

When MR pressure gets access into the air governor through pipe A, it passes through the filter (1) to passage B and then bifurcates in the pipe bracket. A part of this air passes through the passage C at the bottom of the cut out valve. The other portion of the air passes through passage D and work on the cut in tail valve.

Once the MR pressure reaches 10 kg, the pressure acting at the bottom of the cut out valve overcomes the cut out valve spring tension and lifts the valve to get access to passage E. The air pressure acting on cut in tail valve lifts the cut in valve thereby opening the passage from E to F that leads to the top of the unloader plunger. At the same time the upper lips of cut in valve block the exhaust passage G of the casting.

Once the MR pressure goes below 10kg. but remains above 8kg.the cut out valve spring forces the cut out valve to be seated and the passage from C to E is blocked.

But the cut in valve is still kept up with the help of pressure between 10kg to 8kg and the amount of air passing through the cut in tail valve keeps on supplying air to the unloader valve top.

As soon as the MR pressure drops to 8kg. or below the cut in valve spring closes the valve and thereby block the passage to F and no further air is supplied to the top of unloader. Further, whatever air is there in the pipe line is exhausted as soon as the cut in tail valve upper lips move down opening the connecting passage G to exhaust port.

- **LUBRICATION**

The lube oil system of the expressor is a separate system independent of the lube oil system of the engine. Lubricating oil of SAE 30 or SAE 40 grade is filled in the sump of 21 ltr. capacity. A gear type pump under hung from the crank- shaft journal and is driven through sprocket and chain. The sump oil is sucked through a strainer filter screen by the pump and then circulates the same to the journal bearings at a pressure between 45 psi to 60 psi. It also lubricates the small end bush of the connecting rods and the cylinder liners. A connection is taken from the pump housing to the stem valve, lift of which indicates adequacy of oil pressure. A relief valve is also provided to release oil pressure in case the pressure in the system is beyond its usual limit.

- **EXPRESSOR CRANK CASE VACUUM**

The expressor crankcase must have some vacuum to prevent oil throw over through the exhaust by preventing development of pressure in the crankcase.

Crank case vacuum is maintained by connecting the vacuum pipe to the crankcase by a pipe connection through the crank case vacuum-maintaining valve. Normally in well-maintained expressor a differential of 5" of vacuum is considered ideal. In other words when train pipe vacuum is 22", the crank case vacuum should be 17". It has been experienced that oil throw over and sticking of expressor valves (with its consequential adverse effects) are inversely proportional to the amount of crank case vacuum.

It is advisable to take expressor for attention, once the crank case vacuum drops below 15".

- **ALIGNMENT OF EXPRESSOR**

Though the expressor is coupled up with the engine extension shaft through the medium of flexible splined coupling, special care has to be taken for ensuring proper alignment at the time of installation. The following checks are required to be made: -

(1) SHAFT SEPARATION - While installing the expressor it is to be ensured that a gap is left between the expressor crank -shaft and the engine crank- shaft ends. A maximum of 9/16" is recommended to be maintained between the two ends.

Similarly distance of maximum 3.3/8" and minimum of 3.1/8" is required to be maintained between the two hubs which are shrunk fitted on to the taper ends of engine extension shaft and expressor crank shaft. To determine the correct hub separation and shaft separation, as mentioned above, the distance from the end of each sleeve to the end of the hub is to be measured without dismantling the expressor. The distance should be between 2.1/2" to 2.3/4"

(2) ANGULAR MISALIGNMENT - During installation of the expressor it can suffer from angular misalignment in vertical plane, horizontal plane or may be a combination of both. In order to ensure that there is no angular misalignment the distance between the two hubs should be kept equal all-round the circumference of the hub face. A tolerance of + 0.006 only is permissible. This measurement is to be taken at the outer circumference of the hub-face with the help of micrometer at every 90 degree.

(3) OFF-SET MISALIGNMENT - There may not be any angular misalignment, but there may be offset misalignment. For checking offset misalignment use a dial indicator, fitted on the expressor crankshaft nut with suitable clamping arrangement. While the crank -shaft is manually rotated with the help of expressor cooing fan and the limit of 0.0008" is to be maintained.

Judicious use of jackscrews is to be made for inserting or removing shims at the base for correction of

misalignment and also for lateral shifting of the expressor.

(4) BACK – LASH – In view of the facts that the couplings are splined type flexible couplings, some amount of clearance between the male and female couplings is provided. Back –lash of 0.024" at 3.1/2" radius is to be maintained when new. Thus, when two sleeves are coupled together a total back- lash of 0.50" should be there. The maximum limit permitted after use is 0.001" at 3.1/2" radius. The back –lash measurement is also done with the help of a dial indicator while moving the sleeve by hand.

- **SUMMARY**

The expressor is located at the free end of the engine bloke and driven through the extension shaft attached to the engine crank –shaft. Expressor is a combined unit of exhauster and compressor. The main function of exhauster unit is to create vacuum 22'' in train pipe. Air from vacuum train pipe is drawn into the exhauster cylinders through the inlet valves during its suction stroke and that air is thrown out to atmosphere during compression stroke through discharge valves.

The main function of compressor unit is to create air pressure in main reservoir of locomotive upto 10kg/cm2. Atmospheric air is drawn into the compressor LP cylinder through the open inlet valves during suction stroke and same air is discharged to HP cylinder through discharge valves and delivery pipe. The HP cylinder compress the air at high-pressure and discharges it in main reservoir of locomotive for the use of brake system.

- **SELF ASSESSMENT**

1 Describe the function of exhauster unit?
2 Describe the function of compressor unit?
3 Describe the function of loading-unloading arrangement of compressor unit?
4 Why crank case vacuum is provided in expressor?
5 Describe lube oil system of expressor?