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STUDY OF APPLICATION OF VACUUM TECHNOLOGY

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ABSTRACT

Vacuum is now required for many scientific and industrial purposes. It is widely applied in the chemical sciences both in research and industry.

Many other areas, ranging from the study of short-lived atoms and free radicals to the design and deposition of smart coatings on glass for solar control, could not have significant progress without suitable vacuum systems.

In this paper we have discussed about what is vacuum, what is vacuum technology and its applications. In train brakes, vacuum plays an important role. The other wide application of vacuum technology is vacuum distillation in petroleum refining. Without vacuum all these processes are not possible.

I. INTRODUCTION

1.1 Introduction to Vacuum [1,4]

Vacuum is a volume devoid of matter. A vacuum is defined as a diluted gas, or the corresponding state at which its pressure or density is lower than that of the ambient surrounding atmosphere. Because atmospheric pressure fluctuates locally over the Earth's surface and lessens as altitude above sea level increases, it is not possible to specify a general upper limit for the vacuum range.The vacuums achieved in "vacuum systems" used in physics and in the electronics industry are far from being absolutely empty inside, however. Even at the limits of pumping technology, there are hundreds of molecules in each cubic centimeter of volume. Still, compared to the atmospheric density of 2.5×10^{19} molecules/cm^3, the relative crowding is much less in the vacuum system! Vacuum is officially defined by the American Vacuum Society as a volume filled with gas at any pressure under atmospheric. For purposes of interesting physics, the "real" vacuum range does not begin until about 1/1000 of an atmosphere.

1.3 Introduction to vacuum technology [4]

Vacuum technology is the term applied to all processes and physical measurement carried out under conditions of below-normal atmospheric pressure. Vacuum technology is an extremely important tool for many areas of physics. In condensed matter physics and materials science, vacuum systems are used in many surface processing steps. Without the vacuum, such processes as sputtering, evaporative metal deposition, ion beam implantation, and electron beam lithography would be impossible. A high vacuum is required in particle accelerators.

Vacuum systems are also used in many precision physics applications where the scattering and forces induced by the atmosphere would introduce a major background to precise measurements.

II. VACUUM BRAKES

2.2 Introduction to Vacuum brakes [5]

An alternative to the air brake, known as the vacuum brake, was introduced around the early 1870s, the same time as the air brake. Like the air brake, the vacuum brake system is controlled through a brake pipe connecting a brake valve in the driver's cab with braking equipment on every vehicle. The operation of the brake equipment on each vehicle depends on the condition of a vacuum created in the pipe by an ejector or exhauster. The ejector, using steam on a steam locomotive, or an exhauster, using electric power on other types of train, removes atmospheric pressure from the brake pipe to create the vacuum. With a full vacuum, the brake is released. With no vacuum, i.e. normal atmospheric pressure in the brake pipe, the brake is fully applied.

2.3 Working of vacuum brakes [5]

The pressure in the atmosphere is defined as 1 bar or about 14.5 lbs. per square inch. Reducing atmospheric pressure to 0 lbs. per square inch, creates a near perfect vacuum which is measured as 30 inches of mercury, written as 30 Hg. Each 2 inches of vacuum therefore represents about 1 lb. per square inch of atmospheric pressure. The vacuum in the brake pipe is created and maintained by a motor-driven exhauster. The exhauster has two speeds, high speed and low speed. The high speed is switched in to create a vacuum and thus release the brakes. The slow speed is used to keep the vacuum at the required level to maintain brake release. It maintains the vacuum against small leaks in the brake pipe. The vacuum in the brake pipe is prevented from exceeding its nominated level (normally 21 Hg) by a relief valve, which opens at the setting and lets air into the brake pipe to prevent further increase.

2.5 Operation on Vehicle [5]

Brake Release

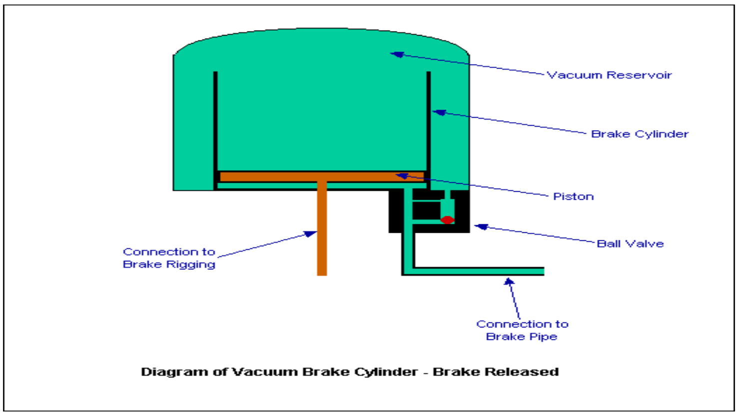

Figure No.2 shows the condition of the brake cylinder, ball valve and vacuum reservoir in the release position. The piston is at the bottom of the brake cylinder. Note how the brake cylinder is open at the top so that it is in direct connection with the vacuum reservoir. A vacuum has been created in the brake pipe, the vacuum reservoir and underneath the piston in the brake cylinder. The removal of atmospheric pressure from the system has caused the ball valve to open the connection between the vacuum reservoir and the brake pipe. The fall of the piston to the bottom of the brake cylinder causes the brake blocks to be released from the wheels.

Brake Application

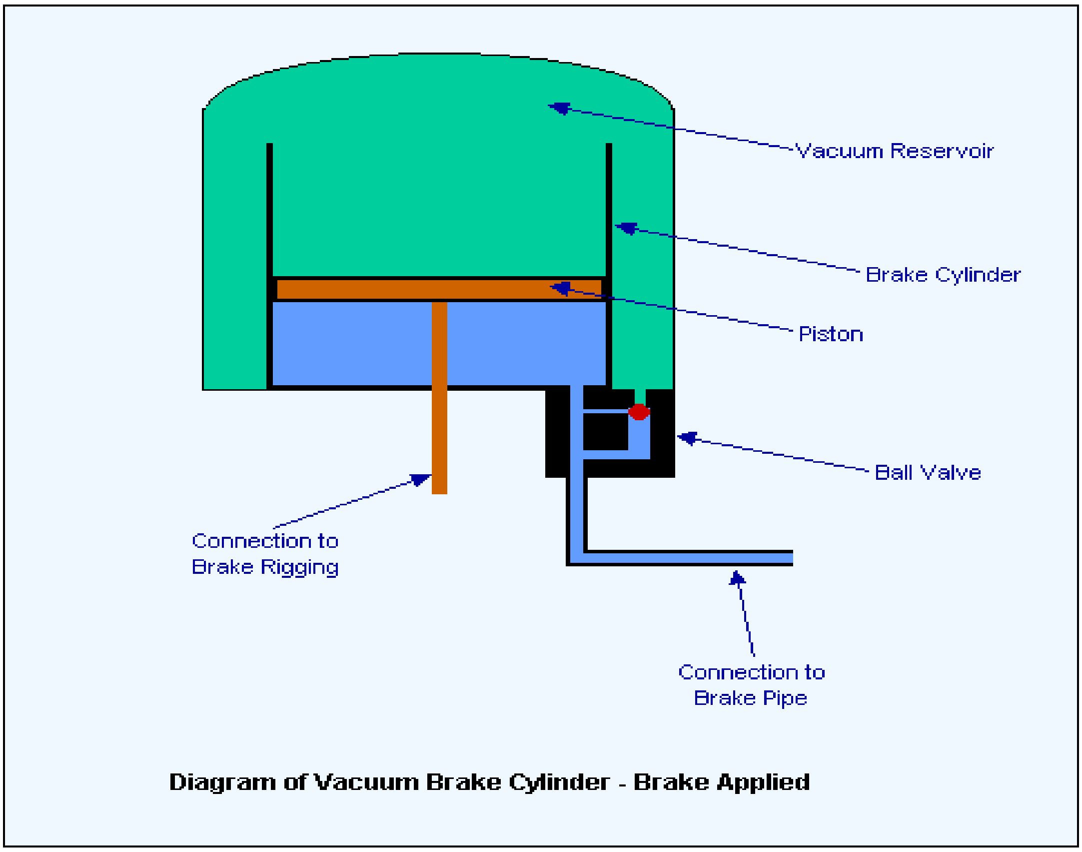

Fig. (3) : Brake Applied

Figure No.3 shows the condition of the brake cylinder, ball valve and vacuum reservoir in the application position. The vacuum has been reduced by the admission of atmospheric pressure into the brake pipe. This has forced the piston upwards in the brake cylinder. By way of the connection to the brake rigging, the upward movement of the piston has caused the brake blocks to be applied to the wheels. The movement of the piston in the brake cylinder relies on the fact that there is a pressure difference between the underside of the piston and the upper side. During the brake application, the vacuum in the brake pipe is reduced by admitting air from the atmosphere. As the air enters the ball valve, it forces the ball (in red in the diagram above) upwards to close the connection to the vacuum reservoir. This ensures that the vacuum in the reservoir will not be reduced. At the same time, the air entering the underside of the brake cylinder creates an imbalance in the pressure compared with the pressure above the piston. This forces the piston upwards to apply the brakes.

III. CONCLUSION

- Many processes in physical and chemical industry require vacuum for their working.
- In applications like Train brakes and distillation in petroleum refining which we have discussed, Vacuum plays an important role.

- The need to integrate heat treating equipment on the shop floor and into the production flow of the manufacturing process is a major reason for the growth of vacuum carburizing.
- The operation of the vacuum brake equipment on each vehicle depends on the vacuum created in the pipe.
- With no vacuum in the brake pipe, brake is fully applied.
- Distillation of crude oil is carried out below 370 to 380 °C
- Vacuum Carburizing with either oil or gas quenching capability has demonstrated its excellent cost effectiveness for gear heat treatment.

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