# Charpter II

# SYSTEM DESIGN

In this chapter the design principles and the functions of the important components, a Cyclone, and a pickup nozzle, of a Cyclone conveyor will be introduced. In addition, the system of a Cyclone conveyor will also be described.

## 2.1 Design of Cyclone

In the design of a Cyclone it is desired that a boundary of rotating air-cyclone is divergent similarly to an inverted cone. Therefore, the designed Cyclone is in the shape of an inverted cone with an apex cut at a desired bottom-end diameter. The reason for cutting the apex is to provide space for an inlet nozzle, and a suction pipe for the Cyclone.

The Cyclone, therefore, (see Fig. 2-1) consists of an inlet nozzle, a suction pipe, and a discharge pipe. The principle of operation is that the compressed air is supplied tangentially through the inlet nozzle into the bottom of the Cyclone; the compressed air then expands and rotates in a Cyclonic motion. The ambient air is sucked through the suction pipe by the vacuum produced in the Cyclone. Both the ambient air and the compressed air are mixed within the Cyclone and then tangentially discharged through the discharge pipe.

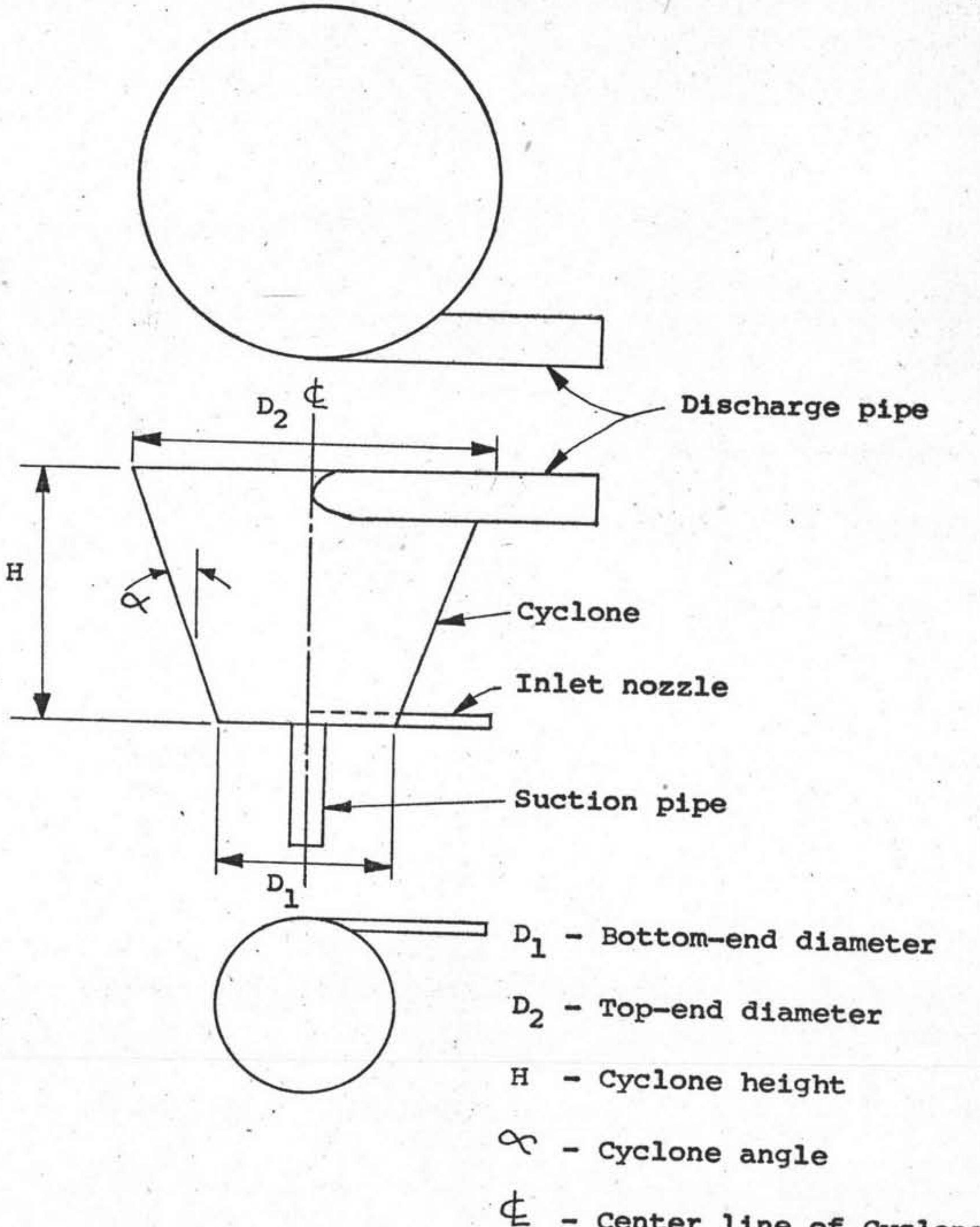


Fig. 2-1 A CYCLONE

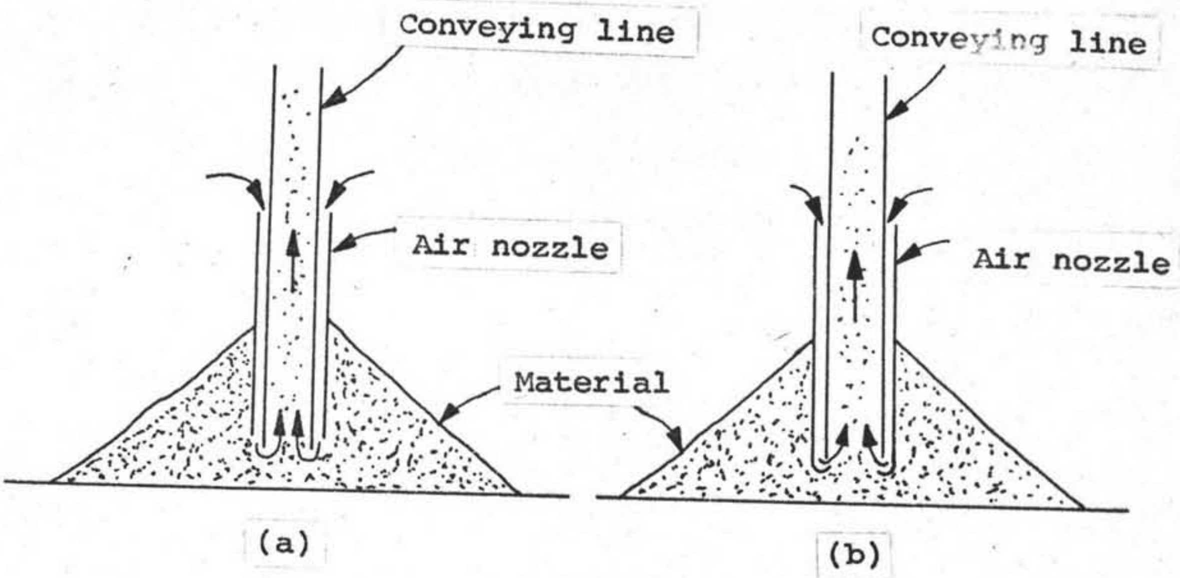


Fig. 2-2 PICKUP NOZZLE DESIGN

In investigating the characteristics of the Cyclone the following parameters are considered :

(a) Pressure of compressed air supplied, or flow rate of compressed air supplied to the Cyclone.

(b) Inlet nozzle diameter.

(c) Discharge pipe diameter.

(d) Cyclone height.

(e) Cyclone angle.

(f) Suction pipe diameter.

(g) Bottom-end diameter of Cyclone.

In this study the values of inlet nozzle diameter, discharge pipe diameter, suction pipe diameter, and bottom-end diameter of the Cyclone are kept constant. These constants are chosen arbitarily (see Table 2-1). The other variable parameters are shown in Table 2-2.

## 2.2 Design of Pickup Nozzle

The pickup nozzle is used to induce air and material into a negative-pressure system. To design the air nozzle two principles are considered. In the first case the air is sucked through the air nozzle and the airstream conveys material into the conveying line (see Fig. 2-2,a). In the second case the air is sucked through the air nozzle; both airstream and material are induced by vacuum into the conveying line or it can be said to be fluidized (see Fig. 2-2,b).

TABLE 2-1 FIXED PARAMETERS OF CYCLONE

| Description | Dimension (mm) | Remark |
|---|---|---|
| Inlet nozzle diameter | 4.90 | 1/8 in.O.D., Copper tube |
| Discharge pipe diameter | 26.00 | 1 1/8 in O.D., Copper tube |
| Suction pipe diameter | 11.43 | 1/2 in O.D., Copper tube |
| Bottom-end diameter, $D_1$ | 75.00 | |

TABLE 2-2 VARIABLE PARAMETERS OF CYCLONE

| Description | Range of Variation |
|---|---|
| Cyclone height | 7.5 - 45 cm |
| Cyclone angle | 0 - 20 degrees |
| Pressure of compressed air supplied | 34.5 - 344.6 $kN/m^2$ (or 5 - 50 psig) |

The advantage of the first type of nozzle is the coveying of material with large grains because there are a lot of voids, thus, there is no blockage at the entry of the pickup nozzle. However, the advantage of the second principle is the conveying of material with any grain size without any blockage at the entry of the pickup nozzle.

The conveying of materials with fine grains is studied in this experiment; therefore the model of the pickup nozzle in Fig. 2-2,b is designed. The designed pickup nozzle is shown in Fig. 2-3.

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## 2.3 System of Cyclone Conveyor

In this section the system of the Cyclone conveyor is described (see Fig. 2-4). In the operation of this system, an air compressor supplies compressed air through an inlet nozzle and into the Cyclone. The flow rate of the compressed air is controlled by a pressure regulator. The expansion of the compressed air in the Cyclone causes a cyclonic motion of air. Then the cyclonic motion of air produces a vacuum in the Cyclone. Air and material are induced by the vacuum through a pickup nozzle and a suction line into the Cyclone. The remain power of the compressed air conveys air and material through the discharge pipe and discharge line to the cyclone receiver.

It is seen that this system can be compared to a combination vacuum-pressure system (Fig.1-3). The suction part of the Cyclone is equivalent to the vacuum system and the

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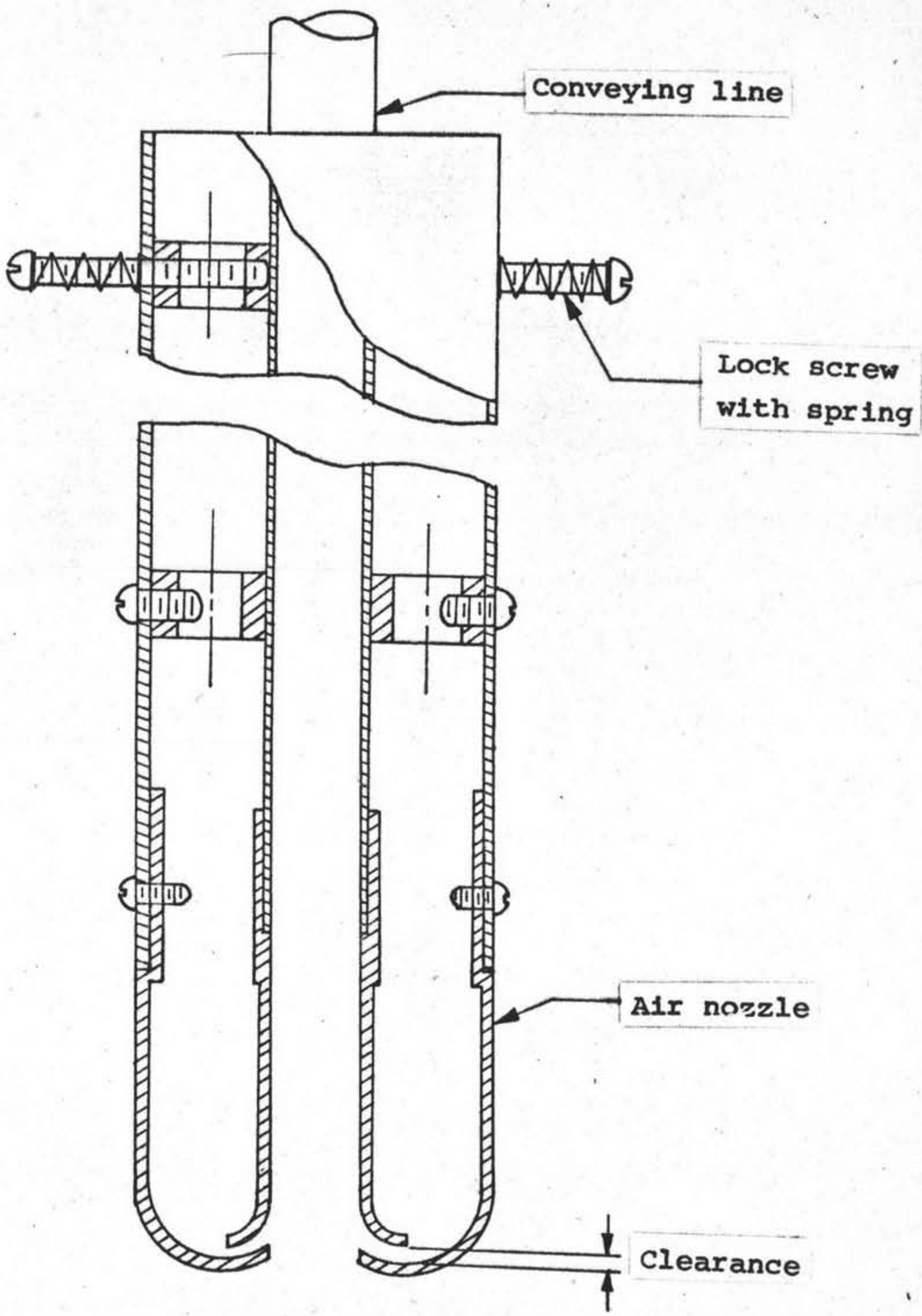


Fig. 2-3 SECTION VIEW OF PICKUP NOZZLE

discharge part belongs to the pressure system. On the other hand it can be said that the system of the Cyclone conveyor is a new variation of a combination vacuum-pressure system.

The differences between the system of Cyclone conveyor and the system in Fig.1-3 are : The Cyclone is used to produce a vacuum for the vacuum system instead of the exhauster. The remaining power of the compressed air is used for conveying material into the pressure system instead of supplying by the blower. In addition this system does not need the cyclone receiver of the vacuum system to separate material supplied to the pressure system. Thus, the proposed system contains less moving parts and machinery.

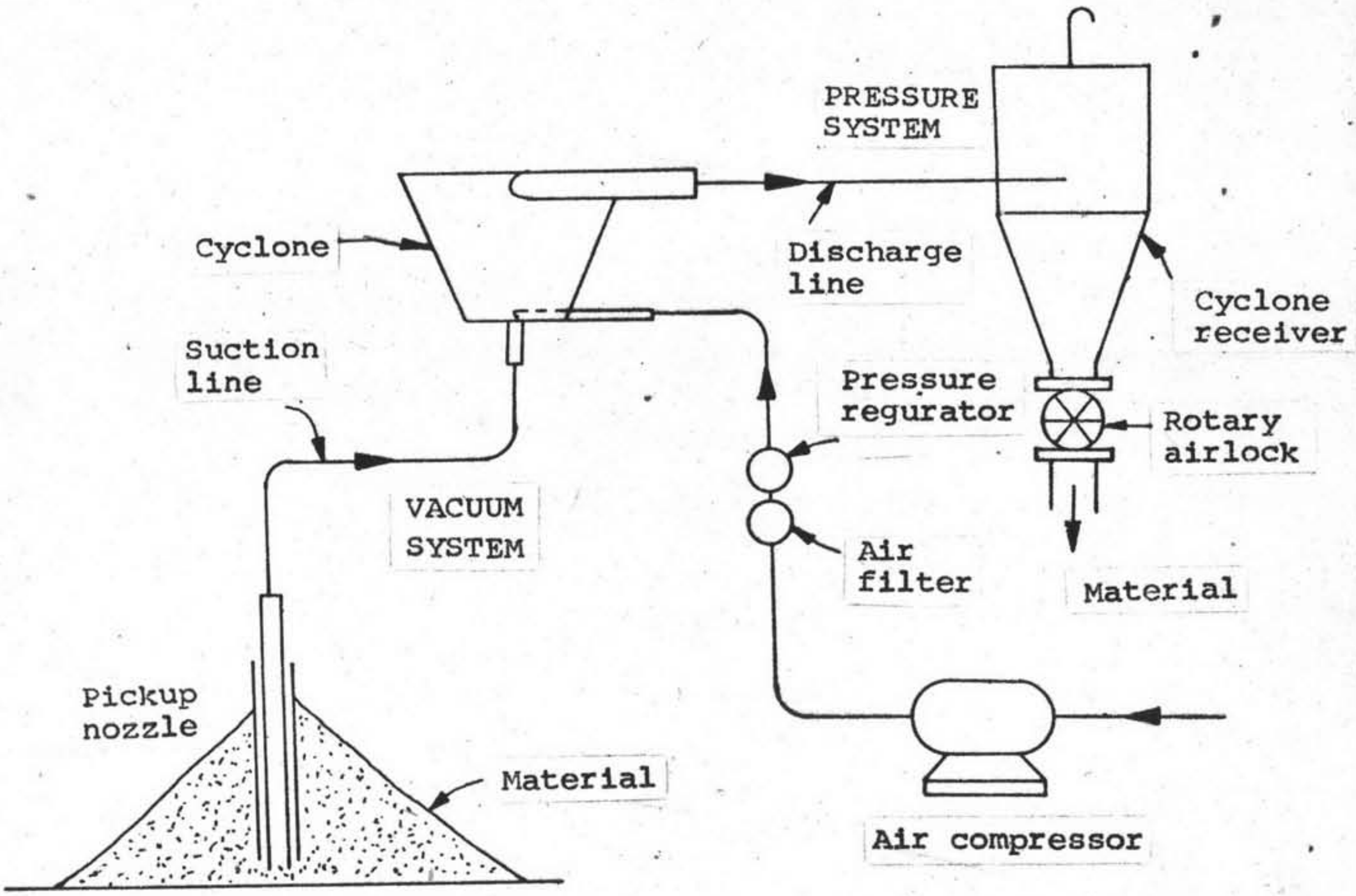


Fig. 2-4 SYSTEM OF A CYCLONE CONVEYOR