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BREATHE BRICK

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Abstract - *Breathe brick is a masonry system that filters the polluted outdoor air to improve the indoor air quality. This system does not use any filtration technique for separating suspended particles. The air itself creates the filtration effect. The brick is modified to have a faceted shape to direct the airflow into the brick. The pressure and temperature differentials are considered for directing the particle-laden air to the brick. Cyclonic separator, which is the cheapest and efficient type of separator is adopted as the major component of breathe brick. The efficiency of cyclonic separator depends on particle size and velocity. It shows 70-80% efficiency in solid separation, if the fluid contain large amount of solid particles the separation efficiency exceeds 99%.*

Key Words: *Breathe brick, faceted surface, Cyclonic separator, Plastic coupler, Wind Tunnel Test*

1. INTRODUCTION

The existence of life on earth is impossible without air. The quality of air is an important factor, which requires special consideration in the current scenario. Degradation of air quality leads to many problems that affect humans as well as environment. Air pollution is one of the major problems haunting the earth since the beginning of industrial revolution. As a result, the need for innovative ideas to improve the quality of air is having huge demand. Carmen G Trudell and a group of undergraduates introduced the design of breathe brick which adopted the methodology of vacuum cleaner to improve the quality of air. Formation of 'black cloud' in the city of Cairo that lasted for several months was the cause behind the innovation. The design aims to purify the air entering into the brick so that the air expelling out will be free from suspended particles. The major advantage of breathe brick is that it does not consume energy for the purpose of air purification.

2. COMPONENTS

The components of breathe brick include concrete block, cyclonic separator and plastic coupler. The first design consists of only cyclonic separator and waste stack, and it was found to be very simple design .It was later modified by designing the geometry of cyclonic separator, waste stack and voids for reinforcement bars were provided.

2.1 Concrete Brick

The cyclonic separator is embedded within the masonry component. It is having the same dimensions as the typical masonry unit. Since no separate filter is installed in it, the brick is designed to have a faceted surface to direct the airflow into the system. The air itself creates the filtration effect.

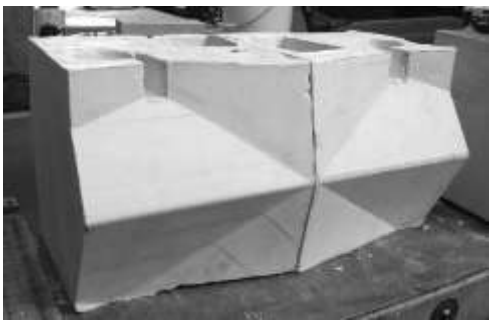

Fig- 1: Breathe brick with faceted surface

2.2 Cyclonic Separator

It is the simplest and cheapest separator with no moving parts and virtually no maintenance. It shows 98% efficiency in removing particles moving at about 15m/s and size larger than 5μm.The upper portion of cyclonic separator is cylindrical and lower portion is conical in shape.The principle of separation in cyclonic separator is to increase the effect of sedimentation by centrifugal force by introducing tangential absorption of air to the device.

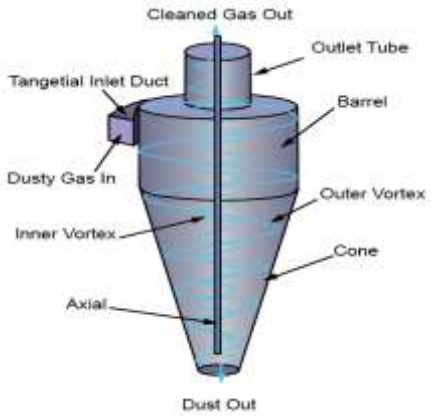

Fig- 2:Cyclonic separator

2.3 Recycled Plastic Coupler

Coupler helps in aligning the blocks and it creates the route for polluted air to enter into the block.Internal baffles are provided to induce directional flow of air within the chamber.It also provide connection to another cyclonic chambers.

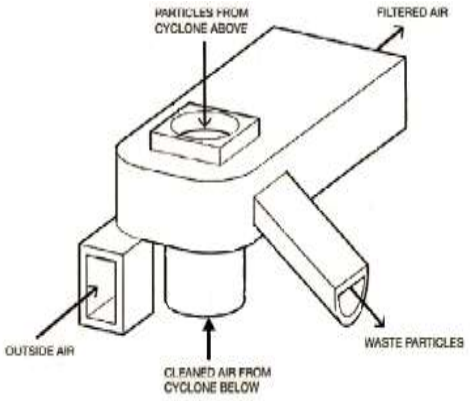

Fig -3 :Plastic coupler

3.BREATHE BRICK ASSEMBLY

The brethe brick is an assembly of 4 modules which are joined together by coupler.The first module consists of cyclonic separator and cavity for reinforcement bars.The second module which has waste tube and reinforcement cavity is kept close to the first module and they are connected by coupler.The third module consists of cyclonic separator ,waste tube and reinforcement cavity.The third unit is kept above the first and second modules.It should be arranged such that the cyclonic separator of first module is coupled with the separator of third module.Similarly the waste tube in second module is coupled with the waste tube of third module.The fourth module consists of only cavity to insert reinforcement bars.These 4 modules are combined together to function as the purifying unit.

Fig -4: Breathe brick assembly

3.1 Breathe Brick Configuration

The air enters into the brick with the combination of wind force and stack ventilation force.Since it works on pressure and temperature differential,the filtration wall is positioned against the privailing wind.It is designed as a part of holistic building ventilation system in which solar orientation and layout are important factors of design.

The breathe bricks are provided as a part of double wall construction.It is provided as the outer non load bearing wall of double wall system.The inner wall is provided as load bearing wall.The polluted air from external environment is purified by the outer filter wall and purified air is allowed to enter into the room.The breathe brick acts as a passive filtration system in case of normal room which provide vents for the entry of expelled fresh air .It operates as an active system when it is integrated with the existing HVAC.

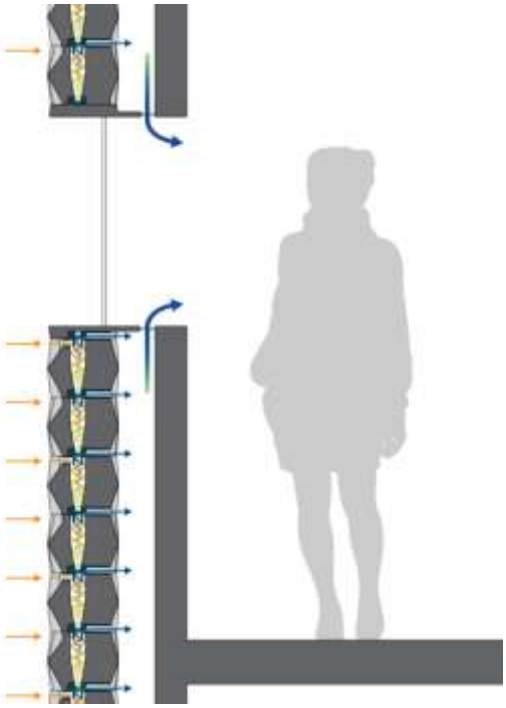

Fig -5: Breathe brick configuration

4.WORKING

The polluted air enters the breathe brick unit via coupler. The air moves through the baffles to reach the cyclonic chamber.The cyclonic separator with a cylindrical upper part(barrel) and conical lower part admits the particle laden air tangentially through the top of barrel. The air induces a swirling motion when it reaches the chamber. The air moves from the barrel to the lower cone due to the high density of particle laden air forming an outer vortex. . The inertial force of the gas particles get transformed to centrifugal force by means of vortex generated by the swirling effect of the particles.As the diameter of cone decreases the velocity of flow of particles increases,which results in increase in centrifugal force.When the particle hits the wall of separator the particle losses their energy and falls down due to gravitational force.The density of air get reduced as the particle is separated from the air. As a result the purified air moves towards the barrel by forming inner vortex and

it is released from the breathe brick unit.The dust particles move through the dust collector shaft and it finally reaches the collection hopper kept at the bottom of wall.The hopper is cleaned periodically by sweeping or vacuuming.

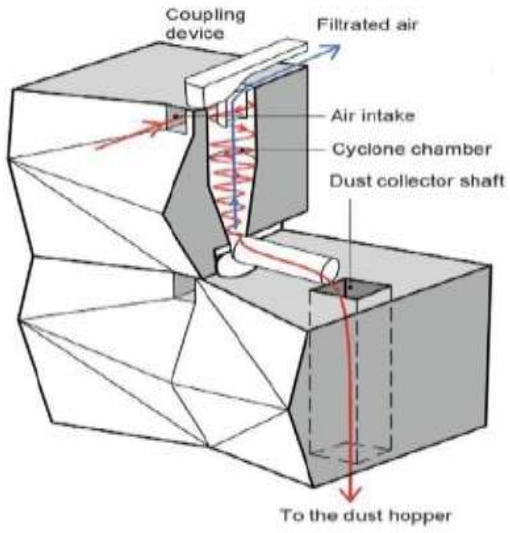

Fig- 6: Working of Breathe brick

5.WIND TUNNEL TEST

Wind tunnel test is conducted to determine the collection efficiency of breathe brick.The experimental setup consists of a cylindrical chamber(about 8 feet long), a fan with low speed is kept at front end to draw the air into the chamber, a funnel to introduce the particles into the chamber,manometer to measure air pressure and an aerodynamic particle sizer(APS).An APS is used to sample the air at different locations. Flour and cornstarch are tested with 4 ft/s and 11 ft/s. The APS used for the experiment is having a maximum size range of 20µm.

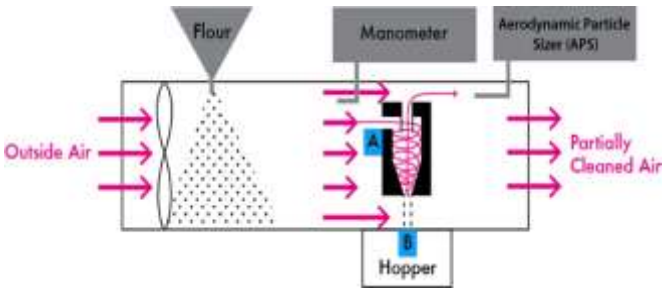

Fig -7: Experimental setup for Wind tunnel test

The experiment gives a collection efficiency of 76% for flour at 4 ft/s and 84% for flour at 11 ft/s.For cornstarch at 11 ft/s the efficiency was found to be 95%. Hence the result obtained shows that the particle collection efficiency increases with increase in particle size and air velocity. It also shows that the particles having size more than 0.5 µm can trapped by breathe brick.The breathe brick shows 30% efficiency for fine particles such as air borne pollutants and 100% efficiency for coarser particles such as dust.

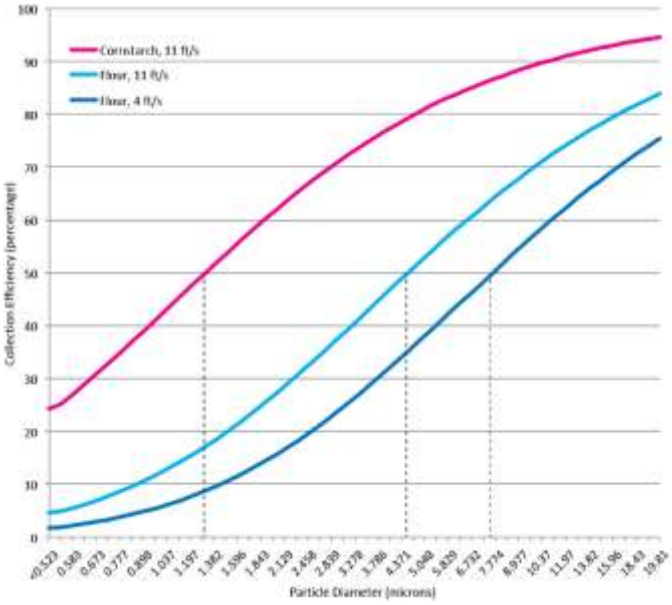

Fig- 8: Particle collection efficiency curve

6. CONCLUSION

Pollution is a problem, which requires immediate attention and the world is in haste for a solution. Breathe brick is an efficient solution for the problem of pollution. This system is extremely useful for regions under highly polluted category. They are inexpensive and easily affordable by average income families. They are also energy efficient since they do not require energy for the functioning. This performs the function of improving air quality inside the room thereby reducing health issues of people to a great extend. Constructing breathe brick walls ensures fresh and healthy air to the people living in busy cities and towns. Hence adopting breathe brick as a construction practice can benefit to develop a healthy living condition.

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