Technical paper

Stack-aerator system principles

Balancing the pressures

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Abstract

In this paper the principles of the Stack-aerator systems will be presented. Balancing the pressures in the system and keeping them close to atmospheric is the main issue for these systems in order to keep the water traps of sanitary devices in place. An open path to the environment must be present for all the air in the system to avoid pressure surges and thus blow outs of siphons. To achieve this special fittings are used on every level of the building where branches enter the stack.

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Introduction

A lot of waste water is produced daily by toilets, bath tubs and showers, dishwashers, washing machines, etc. It all has to be drained from the buildings and transported to the sewage facilities.

If a single drainage pipe would be used that is just capable of draining the maximum amount of waste water, large pressure peaks would result, sucking dry or blowing out all water traps, giving access for bad odors to enter the living spaces.

In order to keep the pressure fluctuations low the system has to be ventilated. An additional ventilation stack can do the job, but is a more complicated construction, costing considerably more, and takes up more valuable space in building shafts. The answer is a single stack system using stack-aerators. The principle of this system is based on keeping a free path for air to leave or enter the system, thereby keeping the pressure level within acceptable limits.

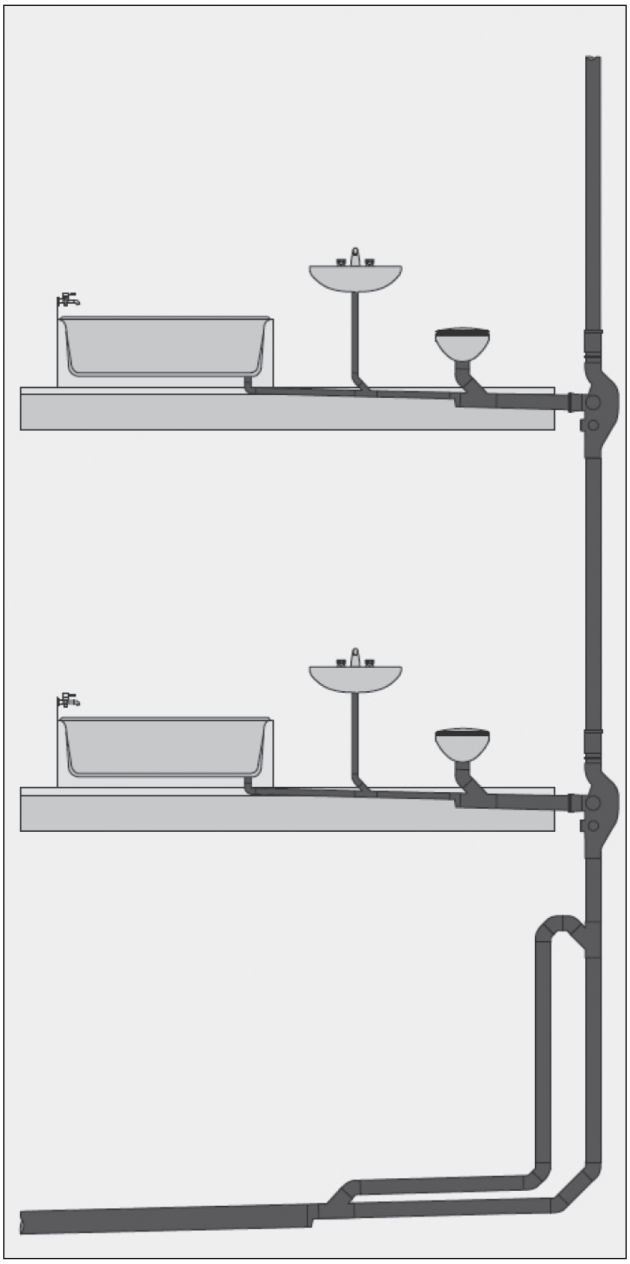

Figure 1.
Schematic of a single stack system with stack-aerators

Stack-aerator system

When fluid is transported in a pipe system at a low discharge rate relative to the maximum discharge rate of the pipe system a so called annular flow will occur in the vertical pipes. This means that the water will flow along the walls in an annulus independent of the initial inflow conditions. In the center of the pipe a core of air will occur. If the vertical stack sticks through the roof and is open the core of air will always remain at approximately the atmospheric pressure.

This in contrast to a plug flow that can block the air path at any location in the pipe system. In front of the plug of water that cuts off the open air path a pressure peak will occur, whereas a wake with a vacuum behind the plug will be present. The pressure peak in the front will also enter the side branches and possibly blow out the water traps. When the water traps are able to withstand the pressure peaks they are threatened a moment later by the vacuum of the wake that can suck them dry. Both will lead to an open path for smelly sewer gases to enter the building.

To keep the water traps in place the pressure has to be kept at approximately atmospheric level in the side branches also. To manage this the air in the branches have to be in contact with the air core of the stack at all times. This is where the stack-aerator plays an important role.

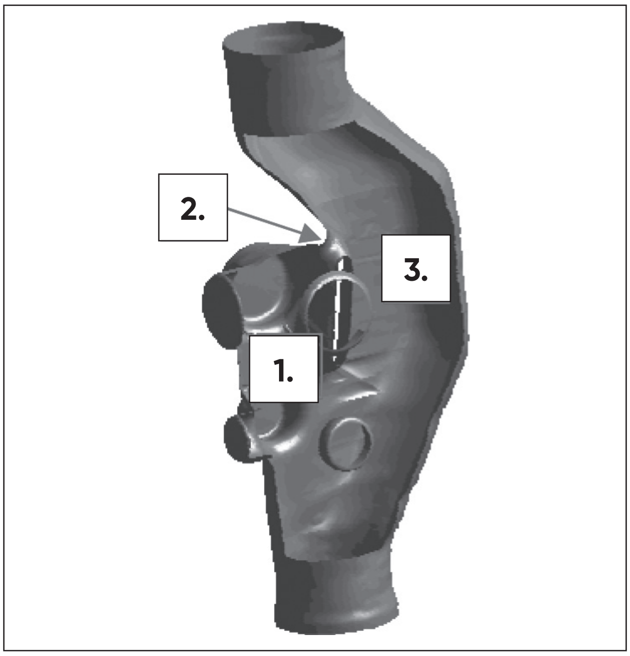

Figure 2.
Stack-aerator

In the branches the air is located at the upper half of the horizontal pipe (gravity driven separated flow). If the horizontal branch is plugged straight into the stack the water would jet in with sufficient force to disrupt the core of air and thus disturbing the pressure balance in the system. The stack-aerator collects the water in a separate mixing chamber [1] before it drops down and flows in vertically to the main stream. The air in a branch connects with the core of air in the stack through a ventilation hole [2].

The main vertical water stream is offset by the deflection in the bend [3] of the stack-aerator.

At the bottom of the vertical stack the flow is channeled horizontally. The system has to maintain ventilated through this bend also. Directly after this bend there is a risk the system will be blocked by the hydraulic jump that will occur because of the deceleration of the water in the corner. This threat can be alleviated by constructing a short ventilation stack from just before the bend to a location in the horizontal pipe behind the hydraulic jump as shown in Figure 1.

Conclusion

The single stack system with stack-aerators system is all about keeping the air pressure in the system near atmospheric in order to keep the water traps in place. The special shape of the stack-aerators contribute to a higher capacity whilst keeping the core of air open to ventilate the traps. The hydraulic jump at the base of the stack blocking the ventilation of the system is by-passed using a pressure relief line.

Steve White
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