

# Water Trap Seal

## How it keeps inhabitants safe from sewer pathogens

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### Abstract

The appliance water trap seal was invented in 1770 by Alexander Cummings and was incorporated into Victorian drainage designs to reduce a source of infection spread and a desire to eliminate odour. The simple introduction of a U-tube filled with water capable, due to a water column height designed to exceed any applied air pressure from the system, of preventing any odours within the system from penetrating into habitable space, was a major advance that remains the first line of defence against cross-contamination. It has remained an essential feature of all building drainage design since the early 19th century. The depth of the water seal, 50 or 75 mm, is sufficient if properly retained to prevent any passage of air into habitable space from the drainage network. Understanding what leads to the depletion of water traps seals and the barrier that they provide is important for public health. In high-rise buildings even more so after the SARS outbreak in Hong Kong at the Amoy Gardens in 2003 where the infection spread identified by WHO (2003) was exacerbated by poor drainage design and trap seal depilation.

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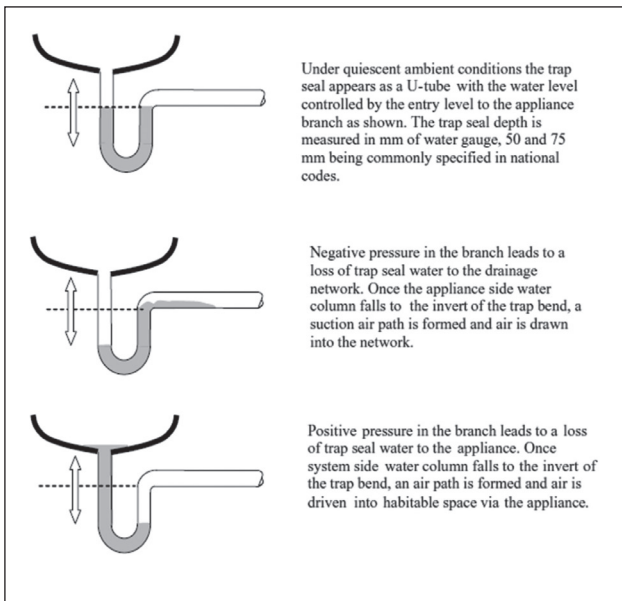


Figure 1.  
Water seal behaviour

## Introduction

The complex building drainage and vent systems in large buildings will entrain airflows at rates many times the driving water flow rate and hence the mechanism by which air entrainment occurs, and the effect of changes in this water flow, determining air entrainment, become vital to an understanding of the pressure regime within the system and the impact that changes in pressure have on the survivability of the appliance traps seals that provide the protective barrier that minimises the risks of cross-contamination between the drainage network and habitable space. Air pressure transients in excess of the depth of the water trap seal will deplete the trap seal. In a high-rise building the trap with the least seal depth will be the trap at most risk of being lost.

## Traps

Traps should be designed so that deposits such as hair, soap and food waste for example do not accumulate in the trap after a discharge through the trap.

The internal surface of the trap should be smooth throughout. All traps should be accessible and should be self-cleaning. There should be no more than one trap on the discharger pipework from any appliance, as the velocity of flow through the gravity generated by the slop will be reduced through a second trap leading to accumulation of solids and the reduction of the water trap seal. a) WC traps typically 50 mm in depth b) Tubular traps typically P or S traps with depths of 50 mm or 75 mm c) Bottle traps with depths of 75 mm d) Anti-vacuum traps with depths of 50 mm or 75 mm with an integrated air admittance valve e) Resealing trap with depths of 75 mm.

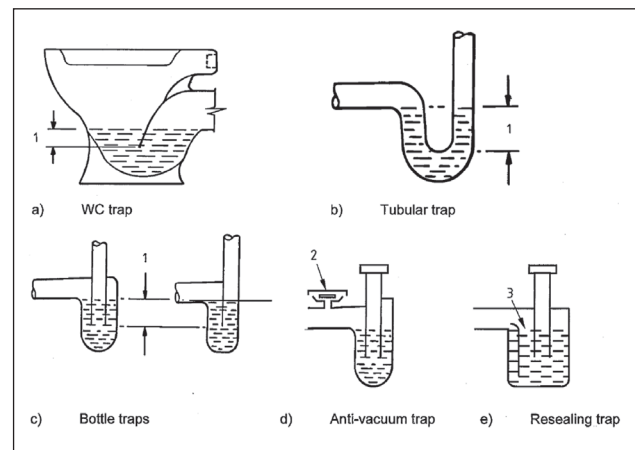


Figure 2.  
Different water traps

## Water trap seal depletion

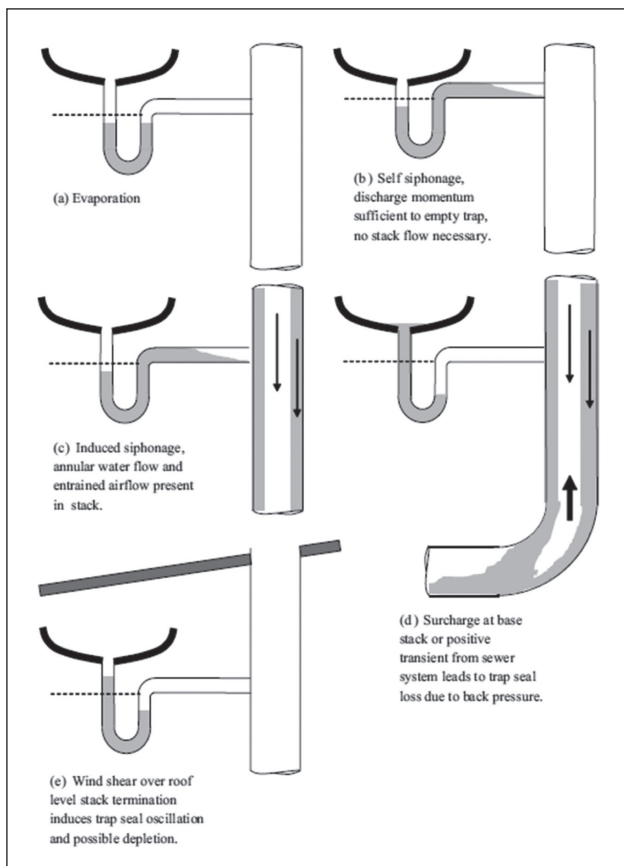


Figure 3.  
What depletes the water seal in a trap

Evaporation, (a), is caused by the local ambient conditions. The routine installation of floor drains in plant rooms is now not advisable as the modes of floor cleansing no longer provide the water needed to 'top up' the trap.

Self-siphonage, (b), is caused by the appliance discharge having sufficient momentum to carry the trap seal out into the connected branch. Wise and Croft (1954) recommended either increasing the branch diameter downstream of the trap, this is now standard practice, or providing a local vent relief by a connection to the vent stack. In more recent times this recommendation may be met by providing a local air admittance valve.

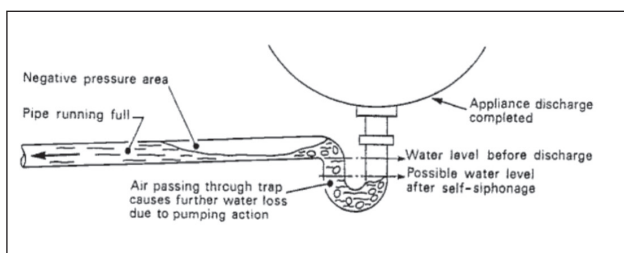


Figure 4.  
Self siphonage

Induced siphonage, (c), is due to the air pressure transients propagating within the drainage network and may be avoided by local venting or careful selection of the branch diameter and slope in single stack applications.

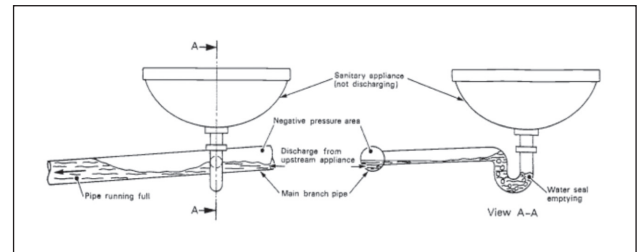


Figure 5.

Back pressure, (d), is due to positive air pressure transients generated within the system either by system surcharge, at the stack base or at any stack offset, or by positive pressures entering the network from the sewer, again possibly due to a remote system surcharge or pump operation. If the positive air pressure transient is in excess of 50 mm-100 mm Wg the traps will have cross-contamination to the trap blowing out of the appliance.

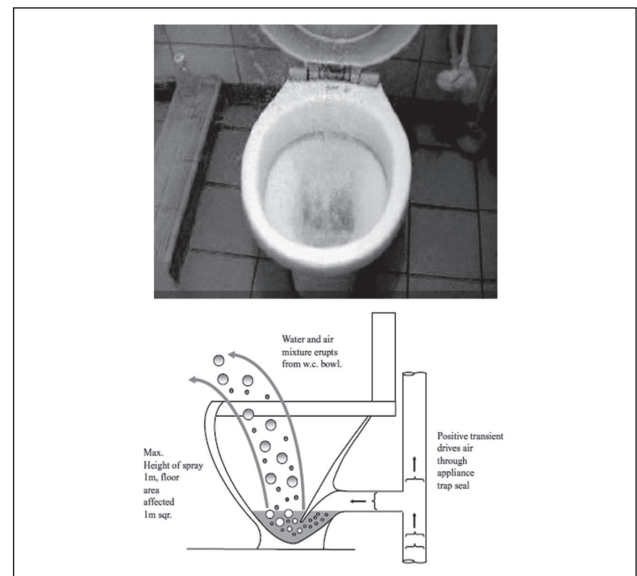


Figure 6.

The solution is to vent the branch leading to the trap or to install a P.A.P.A. locally to absorb the incoming positive transient.

Wind-driven oscillation (e) of the trap seal may occur due to the wind shear over the roof level stack termination and may lead to trap seal loss due to the sinusoidal wave of the wind. If the air pressure transient is in excess of 50 mmWg trap seal loss may occur. Typical wind gusting at 35 Km/h will generate a harmful transient.

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## Conclusion

The majority of trap seal depletion is due to air pressure transients, 2l/s of flow rate can generate an air pressure transient of 50 mm Wg and 50 mm depth trap seals are at risk. An air pressure transient of 75 mm Wg will lead to loss of these traps. To prevent the loss of the trap seals the system should be designed so that the system pressures do not exceed 40 mm Wg. This can be achieved, by using stack-aerators or active drainage ventilation to keep the whole system below +15 mm Wg and place no stress on the water trap seals, so that the barrier is maintained and the risk of cross-contamination can be avoided.

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