

## Study about biofilms, Issue with the use of faucet aerator, in healthcare and it's prevention by using laminar flow device: A review

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### ABSTRACT:

**Purpose Of Review:** The aim is to study about biofilms ,the infections that are transmitted through water by various pathogens due to the growth of biofilms in faucet aerator and preventing it by using laminar flow device.

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**Recent findings:** A faucet aerator is very common in modern day plumbing system. The faucet aerator produces aerated stream of water by mixing air and water in the aerator chamber .due to which some air might get trapped in aerator chamber , as this air contains harmful bacteria which forms biofilms inside the faucet and thus contaminate the water. This isn't a big problem for residential purpose but a major concern for hospital and other healthcare purpose. producing various water born diseases and risking patients life. Summary: Biofilm are aggregation of microorganisms. they get embedded within a self -produced matrix ,of extra polymeric substance(EPS).which adhere to each other or to a surface. The biofilm matrix gets degraded by enzymes secreted during the final stage of biofilm formation . many of nosocomial infections are caused by transmission of gram negative bacilli(NFGNB), Pseudomonas aeruginosa, legionella ,protozoa , fungi through water due to formation of biofilm inside the inner surface of the faucet aerator as air gets trapped in the aerator the growth of such biofilm can be prevented to some extent by using a laminar flow device. As it reverts the turbulent flow into laminar flow stream.

**Keywords:** Biofilm , faucet aerator, laminar flow device

**INTRODUCTION:** In the modern day plumbing system faucet aerator are very common. they are widely used for residential ,commercial healthcare and senior care purposes. Their use in health care (hospital) and senior care is hazardous . As there is a formation of biofilm on the inner surface of the faucet aerator .

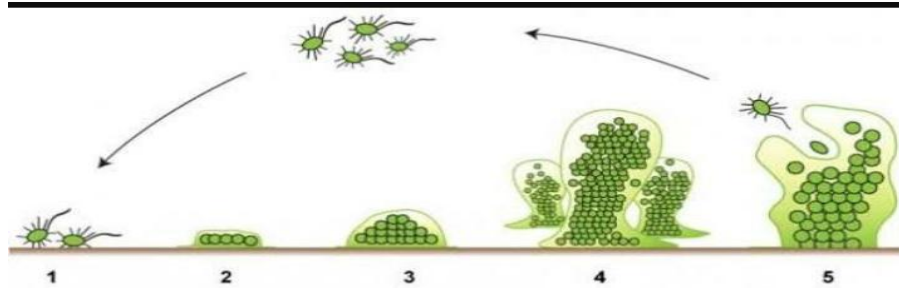
**Biofilm:** A Biofilm can be defined as a syntrophic aggregation of microorganism in which cells stick to each other or to a surface, these cells get embedded in a extracellular matrix composed of extracellular polymeric substance called as (EPS).

### Formation:

The process of formation of biofilm starts with the attachment of a free floating microorganism to a surface. Initially the microorganism get attached to the surface by van der wall forces and hydrophobic effects. This is the first stage of formation of biofilm and is called as initial attachment. In the second stage the microorganism start fixing themselves more permanently . for this various cell adhesion structures (e g. pili ) are used .it is called as the reversible attachment. In the third stage of formation of biofilm, which is called as maturation<sup>1</sup>,the microorganism aggregate together and communicate with each other by using quorum sensing. Quorum sensing help in giving signal about the threshold value of number of microorganism which is required for the formation of extracellular matrix composed of extracellular polymeric substance called as (EPS).

**Extracellular Polymeric substance (EPS)**

The extracellular polymeric substance helps in composing extracellular (matrix). It is produced by cell within the biofilm. The EPS is a combination of polysaccharides, proteins, lipids and DNA. In the fourth stage the number of biofilm increases and hence forms a three dimension structure is formed .this stage is called as maturation 2. In the final stage of biofilm formation is dispersion. Enzymes such as dispersin B and DNA ,degrade the biofilm extracellular matrix



S.No	Common biofilm forming bacterial species
1	<i>E. coli</i>
2	<i>P. aeruginosa,</i>
3	<i>S. epidermidis,</i>
4	<i>S. aureus,</i>
5	<i>Staphylococcus epidermidis</i>
6	<i>E. cloacae</i>
7	<i>K. pneumoniae</i>
8	<i>Actenomyces israelii</i>
9	<i>Haemophilus influenza</i>
10	<i>Burkholderia cepacia</i>

The biofilm are responsible for various infectious diseases dental plaque, urinary tract infection, cystic fibrosis, endocarditis, prostheses .biofilms can be found on rocks, river stream , showers, taps , sewage lines , biofilms are present on teeth as dental plaque.

**FAUCET AERATOR**

Faucet aerator are very common in modern day plumbing system , and can be easily seen in modern day residential commercial and healthcare places. It has an aerator which gives a turbulent flow (flow in which adjacent layer of fluid cross each other ) stream of water. it helps in preventing splashing of water, makes the water to come out in a proper shape and conserving water

In the faucet aerator as air drawn into the water stream, breaks the stream in small droplets mixed with air. The mixture of air and water passes through a screen which gives an evenly spread stream of water .

**Problem with faucet aerator**

In a faucet aerator air and water are mixed together ,to give a evenly spreading stream of water. This air gets trapped inside the aerator when the tap is turned off. Their use in hospitals healthcare, and senior care places is extremely hazardous. As the number of microorganisms in these places is large, when the faucet aerator is turned off the air having large number of microorganism gets trapped inside it, which lead to the formation of biofilms on the inner surface of faucet aerator .due to which various nosocomial infection are cause, risking patients life.

### LAMINAR FLOW DEVICE

Laminar flow is a flow of fluid in which adjacent layer of fluid do not cross each other and move in well - defined path. A laminar flow is possible only at low velocities and when the fluid is highly viscous . But when the velocity is increased or when the fluid is less viscous, the fluid particle do not move in straight path. This flow is called as turbulent flow , A flow is determined to be laminar flow or turbulent by a dimensionless quantity and is called as Reynolds number ( $R_e$ ).

REYNOLD NUMBER =  $\rho V D / \mu$

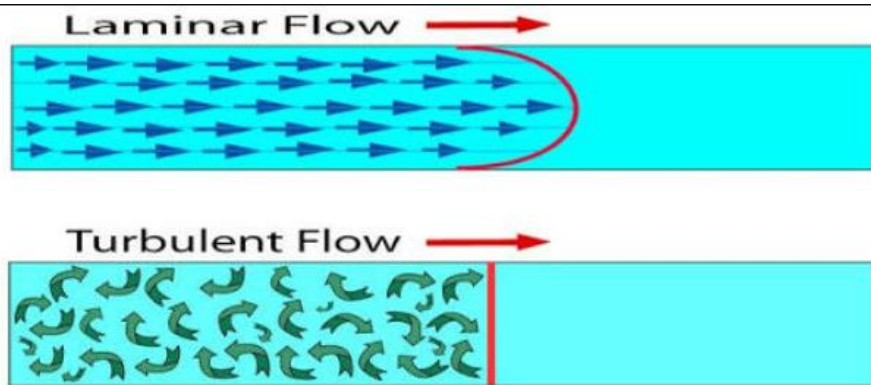
$\rho$  = Density

$\mu$  = Viscosity

D = Diameter of circular pipe

$\mu$  = Dynamic viscosity

For a circular pipe when ( $R_e$  less than 2000) the flow is said to be laminar flow and when ( $R_e$  more than 4000) ,the flow is said to turbulent flow.



The issue with faucet aerator can be solved by the reversion of turbulent flow of fluid (water ) into a laminar fluid stream. This can be done by a laminar flow device. As it does not allows the air to get collected and drawn into the water stream hence giving a crystal clear stream of water.

A laminar flow device produces a laminar fluid flow by reducing the turbulence of the fluid flowing .The major parts of a laminar flow device are

Casing : Provides insulation to the working fluid from surrounding ,it is cylindrical in shape with both ends covered with caps having area equal to cross-section of the cylinder.

Capillaries : They play a very important role as they help to generate laminar flow. The capillaries have a very small cross-sectional area as compared to the casing. A honeycomb structure is ideal structure. The capillaries help in dividing the velocity component of the incoming fluid into smaller component.

Strainer : They acts as filter which avoid the entry of foreign material which may hamper the flow.

The two ends caps have orifice ,the cross-sectional area of orifice at inlet greater than the orifice at outlet .

### CONCLUSION

Biofilms are formed when microorganism aggregate and the cell stick to each other or to a surface . the formation of biofilms in a faucet aerator is extremely hazardous, for health –care purpose as it lead to the transmission of various pathogens through water into the patient body, risking its life . this can be prevented to some extent by the use of a laminar flow device .as it does not allows the air to get collected and mix with the water stream which gives a crystal clear stream of water .

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