

Appliances

Dishwasher particle handling optimization

The second part of this article looks at critical design parameters in prototypes of dishwasher filtration systems to increase particle handling capability and reduce water and energy usage. A simple test compares filtration system performance to optimize dishwasher design.

In dishwashers, particles typically travel along the path of movement from dishware, through the tub and sump, to the drain. This defines three particle handling capacities of the dishwasher:

- washing capacity from dish to tub;
- filtering capacity from tub to sump; and
- draining capacity from sump to drain.

The design of dishwasher wash, filtration and drain systems must therefore adopt a systematic point of view, since the

overall particle handling capacity is determined by the lowest one of the three. In a well-designed, optimized dishwasher, the particle handling capacity should gradually increase at each step along the cycle. This will ensure that particles coming from upstream will always be transmitted to the downstream without creating bottlenecks where accumulation and blockage may interrupt or even force the termination of wash cycles. This article concentrates on the second path, which involves the particles accumulated on, and removed from, both coarse and fine filter surfaces.

Water and particle distribution

A general purpose filtration system test rig shown in Figure 1 was built to study the coarse and fine filter flow rates (Q_c and Q_f), distribution, water pressure/head variation, particle accumulation and removal, etc. The test rig is highly flexible to enable assembly of various filtration/washing system designs. The coarse filter of different hole internal diameter (ID), open ratio (OR), gauge, surface roughness, area and materials can be placed at a different inclination angle, as can the fine filter.

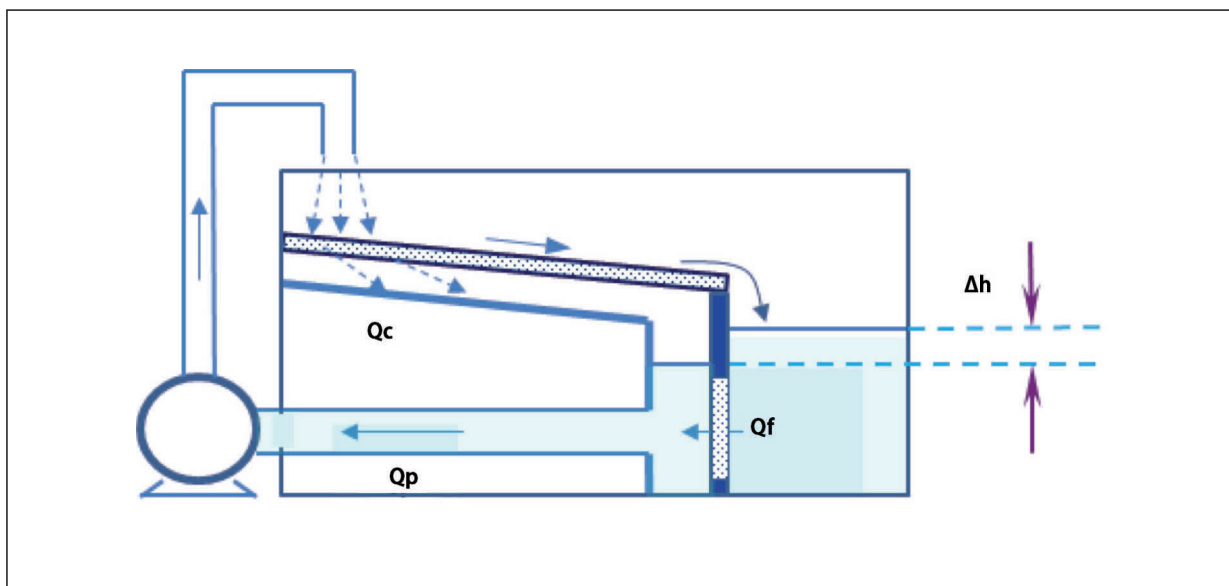


Figure 1: Test rig schematic for water/particle distribution analysis.

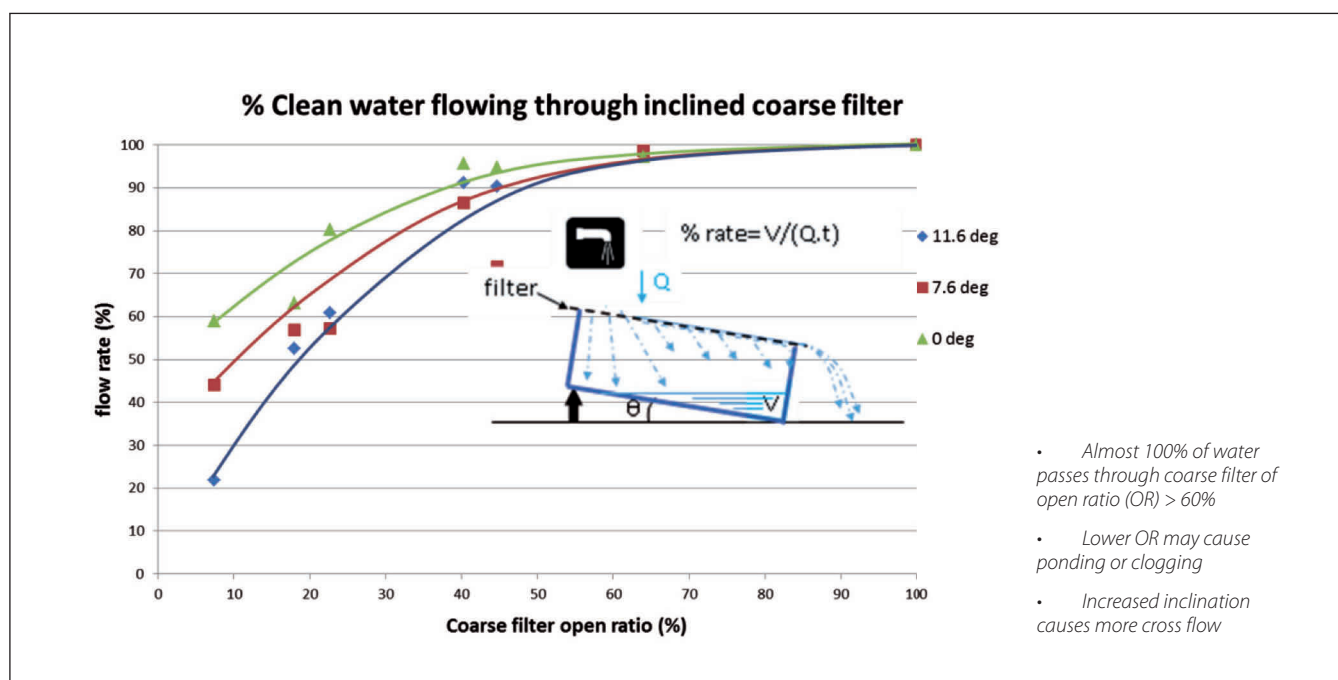


Figure 2: Clean water filter flow rate through inclined coarse filter.

The pump flow rate Q_p can be changed by a switch in the outlet pipeline, and measured/monitored by a magnetic flowmeter. Clean, soiled or detergent-containing water of different fill levels can be used in the test.

Various food particles can be added on the coarse filter surface to quantify the particles remaining on the filter surface or pushed into the sump under various conditions. The transparent box which encloses part of the dishwasher body and sump provides convenient visualisation and evaluation of the test results.

Coarse filter performance

Figure 2 shows that the percentage of water passing through the coarse filter increases with the filter open ratio and decreases with filter inclination angle. While a large open ratio is beneficial in allowing higher through-flow rate, it may decrease the integrity and rigidity of the coarse filter structure and hence has to maintain a certain level. On the other hand, the inclination angle could affect the ratio between the surface flow or cross-flow rate, and the through-flow rate of the coarse filter, with the net water supply equaling the sum of these two.

With larger inclination angles, the cross-flow rate will increase and help clean the filter surface to maintain a large clean area. At the same time, the

unit through-flow rate and the coarse filter efficiency will decrease. More clean water will have to be provided by the fine filter and thereby its workload is increased.

With smaller inclination angles, the coarse filter through-flow rate will increase, bringing more particles onto

filter surface where particles may be accumulated.

Besides inclination, the friction of the filter surface can also affect the water distribution and particle removal. Tests show that the cross-flow rate is reduced if the coarse filter surface is rougher. Some dishwasher manufacturers use a polished coarse filter

"The percentage of water passing through the coarse filter increases with the filter open ratio and decreases with the filter inclination angle."

the filter surface. At the same time, the cross-flow rate and the self-cleaning function of the coarse filter will decrease, resulting in a quick reduction of clean filter surface area and the water supply. This will eventually increase the workload on the fine filter.

Sufficient self-cleaning

The inclination angle therefore has to be optimised and at a value between 5° and 10° sufficient self-cleaning effect is often established without decreasing the filter efficiency dramatically. It is worth noting that the tub surface can be designed to have a large inclination angle and a special profile to direct high velocity water towards the coarse

to reduce clogging. Figure 3 illustrates the effect of friction on the particle movement is larger than that on the water.

While the percentage rate of water and particles travelling along the coarse filter surface are both increased with the inclination, the particle rate is consistently about 20% lower than that of the water. This may be explained by the fact that particles are carried over or pushed down by the cross-flow water, hence large and heavy particles subjected to higher friction force from the filter surface cannot move as fast.

Tests show that it is critical to form a continuous layer of cross-flow on top of the coarse filter surface of a depth

Download English Version:

<https://daneshyari.com/en/article/4988133>

Download Persian Version:

<https://daneshyari.com/article/4988133>

[Daneshyari.com](https://daneshyari.com)