# Application note: PoreXpert modelling of the depth filtration characteristics of a cellulose nitrate filter

Introduction

This application note shows how PoreXpert can be used to simulate the depth filtration characteristics of a cellulose nitrate filter using results from a bubble-point porometer (data from POROLUX™ 1000 porometers are read in automatically). PoreXpert simulates the 3-dimensional void network of the filter. It then feeds in particles from a size distribution specified by the user. From that, it calculates the depth filtration characteristics of the filter in terms of filtration efficiency with respect to particle size and pressure drop (progressive clogging). In this way, PoreXpert can be used to avoid expensive bench tests. The PoreXpert targeted modification facility can also be used to try out the characteristics of filters whose geometry has been modified within the software, aiding the development of new filter designs.

Porometry

PoreXpert converts the porometer data into an equivalent full intrusion characteristic (as output by a mercury porosimeter). This is expressed as percentage intrusion plotted again the equivalent capillary diameter which can be intruded at that pressure, as shown in the screenshot on the right. PoreXpert then generates a void structure which, if put into a porometer, would match this converted data, as also shown.
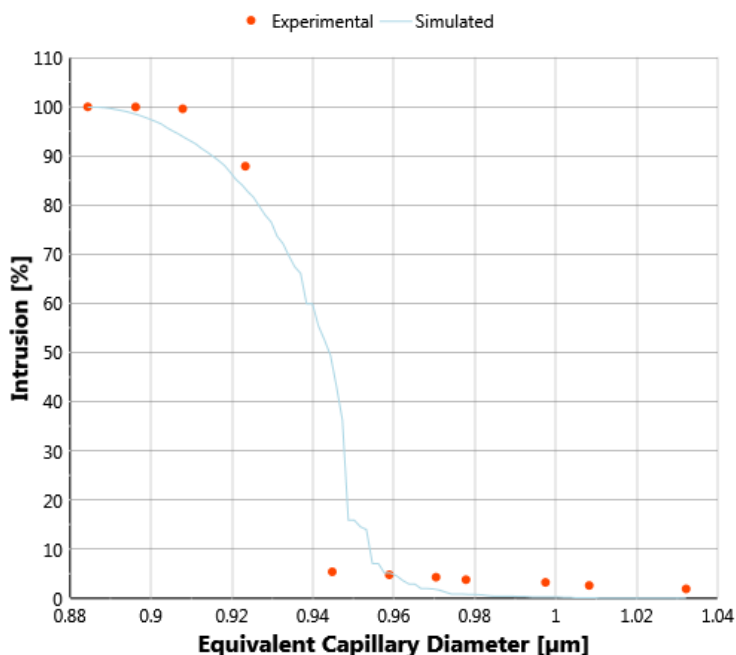
Simulated void structure

The simulated void structure of the filter is approximated as an array of cubic pores connected by narrower cylindrical 'throats'. The figure shows a structure containing 1000 pores connected by up to 3000 throats, which connects together and repeats in every direction to form an infinitely large structure (with periodic boundary conditions). This is a small 'unit cell' shown for clarity – with your own copy of PoreXpert, you can generate structures with 15 times larger volume.
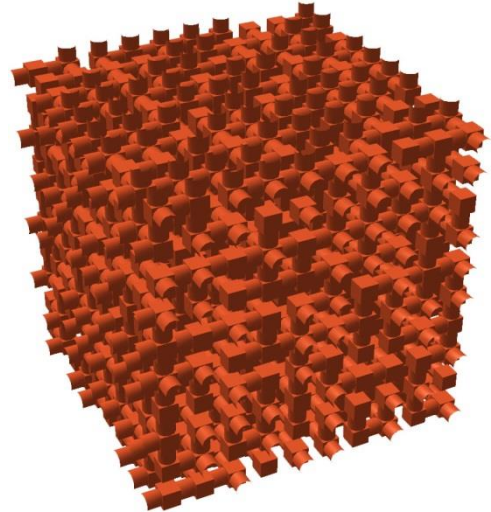
Filtration characteristic

Once constructed, the simulated void structure can be used to investigate many other properties, such as void sizes, connectivity, wetting and absolute permeability. Here we will demonstrate just one – the filtration characteristic. First, the user specifies a particle size distribution. Then PoreXpert randomly chooses particles from this distribution and feeds them one by one into the filter, carried along by calculated flow streams. They may stay on the surface of the filter, as shown in the screenshot below, or be trapped (strained) in the body of the filter, or they may pass through.
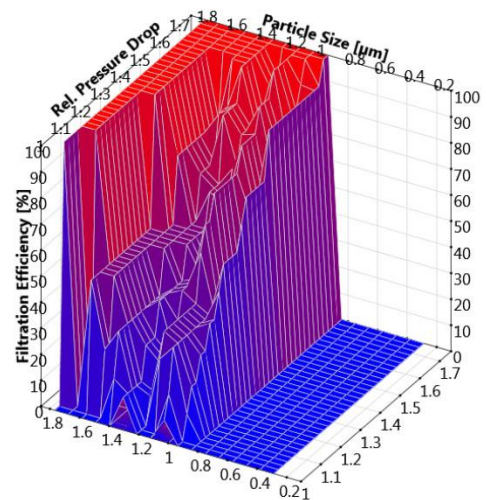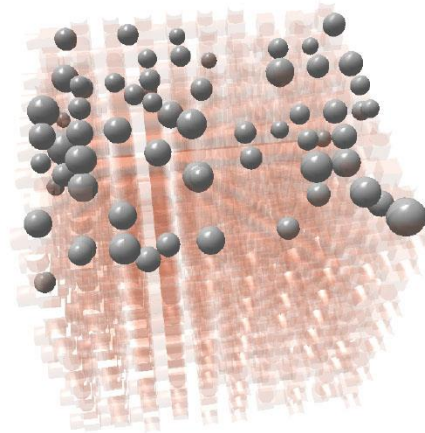
If a particle is trapped, then PoreXpert recalculates all the flow routes through the filter before sending another particle towards it. At each filtration event, it records the pressure drop across the filter which gradually builds up as the filter clogs. At the end of the simulation, a graph is plotted of filtration efficiency (100% = all particles trapped) against pressure drop and particle size, as shown on the previous page.

Simulated geometry modification for development of new filters

Once the void structure has been generated, it can then be modified to simulate the characteristics of a newly proposed filter. In the screenshots below, the pore sizes have been increased by 5%, and the throat sizes by 15%. The particle size distribution has been kept the same. Careful comparison with the previous filtration characteristic graph shows that the filter has become less efficient.
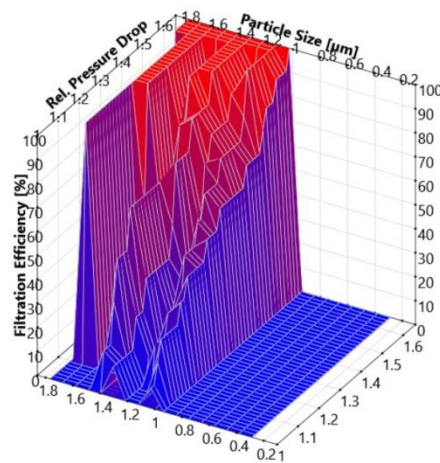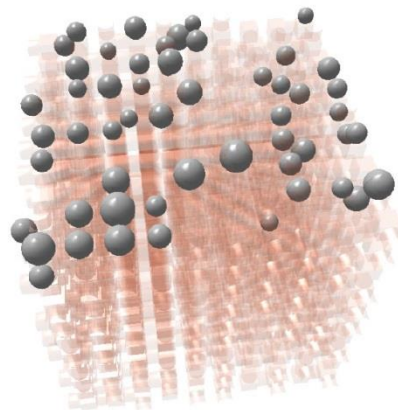
Automated reporting

For ease of use, and particularly for quality control purposes, standard batches of commands can be repeatedly run by the software, and a report of all the results can be automatically generated in pdf format.

Conclusion

PoreXpert provides a brand new and very powerful tool for characterising your current filters and developing new ones. A free trial version of the software (with porometer data modelling but without filtration simulation) is available from a link on the home page of the website
(or go directly to https://www.porexpert.com/userpages/login.php).
If you do not have the resources to learn the software yourself, then you can send a **Contact Us** enquiry from the website to ask about consultancy services.