# Effect of ethanol cleaning on the permeability of FFP2 masks

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## **Objective and principle of the measurements**

#### **Objective:**

To demonstrate the possibility to clean and reuse FFP2 masks

#### Principle:

Like for any porous medium, the permeability of a filter is related to the size and tortuosity of its pores. Any damage of the filter will change its permeability.

In this study we measured the permeability of parts of a FFP2 mask before and after several cleanings with 99% ethanol (1 hour soaking and drying at room temperature)

#### Main conclusion:

After 6 cleaning cycles, the permeability remains very close to the permeability before cleaning.

## Limits of the study (1) – Aerosol tests

#### We have tested only one type of mask;

- we are not sure that the results can be extrapolated to other brands of mask. The problem is linked to the presence or not of "glue" added to the fibers that could be dissolved by ethanol.
- This study demonstrates that the flow properties of the mask (flowrate vs. pressure, linked to the permeability) remain unchanged after ethanol cleaning. This property is one component of the FFP2 ISO standard.
- But we have not verified the property for aerosol filtration defined in the FFP2 ISO standard.
- However, It is highly probable that the aerosol filtration properties are unchanged after ethanol cleaning for two reasons:
  - the permeability measurements prove that the pore structure is unchanged.
  - the ethanol cleaning does not change the wettability of the filter that remains hydrophilic (water wettability is necessary to retain the aerosol droplets).
- This assumption should be confirmed by a laboratory able to perform the aerosol tests.

# Limit of the study (2) – sanitization protocol

Our procedure use 1 hour soaking in 99% ethanol.

- Due to the high porosity and the small thickness of the mask, this time is sufficient do dissolve the aqueous matter trapped in the mask by molecular diffusion.
- We cannot guaranty that the solvent itself (ethanol 99%) and the duration are suitable for a complete sanitization. This point should be confirmed or the procedure improved by specialists.

# **Description of the equipment**

Standard flow cell with pump, flowmeter, pressure sensor and "coreholder"



Standard 16 bit data acquisition board with software CYDAR

### Parts of the mask used for the measurements







Disk 2

2 disks, one on each face (diameter 16 mm)

## **Press and measurement cell**





## **Measurement cell**





#### Bottom end-piece

Top end-piece with the rubber flat seal

# Air pump and sensors



# **Principle of the measurement**

- Due to the high permeability of the mask, the pressure drop across the mask is of the same order than the pressure drop in the tubing and end-pieces.
- We use the following correction
  - pressure/flow rate measurement without mask (blue curve "no filter")
  - Raw data with mask (yellow curve)
  - Corrected data after subtraction of the pressure without filter at each flow rate (green)
- For no filter and raw data, the solid line is a parabolic fit (probably due to inertial effect in the flowmeter).
- The pressure drop across the mask (corrected data in green) follows Darcy's law (linear).



# Permeability measurement on FFP2 mask

- Disk 1, cleaning 1, corrected
- estimated porosity 0.9, thickness 1 mm
  permeability K = 6.5 Darcy
- At maximum flow rate, Reynolds number Re = 0.016 (confirms no inertial effects)





# Disk 1 – FFP2, several cleanings

Pressure as function of flow rate before and after cleaning (up to 6 cleaning cycle)



# Disk 2 – FFP2, several cleanings

Pressure as function of flow rate before and after cleaning (up to 6 cleaning cycle)



# **Several cleanings: permeability FFP2**

- Permeability calculated with 1mm thickness
- no trend of damage, variations are inside the range of error bars (+/- 1 D)



# **Permeability on barrier mask**

A "home made" mask following AFNOR standard was tested

(https://masques-barrieres.afnor.org/home/telechargement?culture=en-GB)





- Permeability is 48 Darcy
- 5 to 7 times higher than that of FFP2 masks

# **Concluding remarks:**

- This study suggests that sanitization of a FFP2 mask with alcohol does not altered its filtering properties.
- Measurements on different brands of masks need to be performed.
- The sanitization protocol was not optimized to guaranty a complete eradication of all germs.
- Measurements of aerosol filtering have not been performed.