Flow and Mass Transfer in a Respirator

Leon Geers, Önder Bilir, Sven van der Gijp

TNO Defence, Security, and Safety
Chemical and Biological Protection
PO Box 45
Rijswijk, 2280 AA
The Netherlands
Email: leon.geers@tno.nl

In respirators, fogging of the lenses, accumulation of carbon dioxide in dead spaces, and transport of contaminants that leaked in are governed by flow. Therefore, knowledge of the flow is essential for the quantification - and consequently the control - of these effects. Additionally, this knowledge can be used for the assessment of test methods for respirators. Due to the complexity of the mask geometry and hence the complexity of the flow, the use of velocity measurement probes (for instance hot wire anemometers) will alter the flow field. Optical measurement techniques (like particle image velocimetry and laser doppler anemometry) require optical access to the space behind the respirator, which can only be provided through the eye pieces. We use local residence time distribution measurements to acquire information on the flow. Although small measurement probes are necessary, flow interference is small and measurements can be done at virtually any position in the space behind the respirator. This technique has been in use for several decades to retrieve data on mixing in industrial reactors, but is relatively novel in the field of respirators. The results of the measurements will be compared to numerical flow simulations in the same geometry using computational fluid dynamics (CFD). First we have investigated the flow pattern in the mask with CFD at a constant breather flow in both laminar and turbulent cases. In this case the flow appears to be steady and laminar with some small turbulent regions. We present further results of the computations and an evaluation of the measurement technique on the basis of the results of both measurements and computations.