High Energy Ventilator (HEV)

A low-cost, versatile, high-quality ventilator

Application: Mechanical ventilation in hospitals (ICU and non-ICU), for intubated and non-invasive cases

Summary: Ventilators provide breathable air to patients who have difficulties in breathing, or cannot breathe. The HEV was born during the COVID-19 pandemic. HEV is a ventilator designed to provide long term alveolar ventilation support to patients, both in and out of Intensive Care, for both intubated and mask/non-invasive cases.

In light of the importance of pressure controlled ventilation modes for COVID-19 patients, the design provides standard Pressure Control and Pressure Support modes, as well as CPAP support. PEEP is provided for all modes, as is patient triggering for both the inhale and exhale parts of the breathing cycle. The pneumatic concept of the ventilator, i.e. ventilation provided via a pressure buffer, allows a precise and safe pressure control and accurate monitoring of flow rates. The step-down pressure design via the buffer puts safety up-front in the design. In addition to the COVID-19 official emergency guidelines from the MHRA, WHO and AAMI, clinical advice has guided the main choices. Priority is in particular given to precise and stable pressure delivery, the simplification of ventilation modes, attention to the trigger timings, and a straightforward and familiar interface for clinicians.

The design is low-cost, rapid and simple to construct and the design choices prioritise low cost, readily commercially available components. The functionality is aimed at the treatment of the vast majority of COVID-19 cases, and is designed to be suitable as a general purpose ventilator beyond COVID-19. The availability of HEV as a ventilator option could free up the very high-end machines for the most intensive cases.

Advantages:

- Design based on MHRA, WHO and AAMI guidelines for COVID-19 emergency ventilators
- Low-cost design based on commercially available components, thanks to the two-step pneumatic design
- Design inherently flexible and modular, for adaption to different requirements and environments

- High quality breath control and breath support, with patient comfort set as a priority
- Air/Oxygen mixing provided internally, no need for an external unit

- Intuitive touch-screen control
- Equipped with standard bulkhead thread connector, for easy adaption to match hospital connectors around the world
- Can be powered by a standard AC connection, or a 24V DC source from a UPS backup
- Internal battery provides up to 45 minutes autonomy, can be augmented with a second battery

Ongoing developments:

- Possibility to use without high-pressure inlet, by using a turbine or compressor
- Optimization of mechanical design for portability
- Possibility of powering with solar panels

Next steps:

- Clinical testing
- Industrialization
- Regulatory approval, or exemption for emergency use

Technology readiness level: Prototype

Contact : KT.MedicalApplications@cern.ch

Publications:

- Buytaert, J., et al. "The hev ventilator proposal." *arXiv preprint arXiv:2004.00534* (2020). https://arxiv.org/abs/2004.00534

Pictures :