National Aeronautics and Space Administration

NASA

TECHNOLOGY SOLUTION

Health, Medicine and Biotechnology

Portable Unit for Metabolic Analysis (PUMA)

Detects hypoxia to ensure health and safety of astronauts, pilots, divers, and miners

NASA's Glenn Research Center has developed the Portable Unit for Metabolic Analysis (PUMA) to provide highly precise real-time measurements of human metabolic functions. PUMA is a battery-powered, wearable device that measures concentrations of carbon dioxide and oxygen in inhaled and exhaled breath as well as heart rate, temperature, gas pressure, and inhalation and exhalation airflow rates. The device relays data wirelessly to a laptop computer for real-time analysis. Because the technology is packaged into a compact and wearable unit and can be used anywhere, a multitude of applications are possible, from ensuring the health and safety of astronauts, pilots, divers, and miners to monitoring patients with pulmonary disease and evaluating fitness levels of soldiers and athletes.

BENEFITS

- Highly Sensitive: PUMA is a unique portable metabolic unit that makes multiple real-time measurements per breath and samples oxygen and carbon dioxide close to the mouth.
- Predicts Hypoxia: The device is the first portable metabolic unit that senses and predicts the onset of hypoxia, a dangerous condition that results from inadequate oxygen.
- Proven: The technology has been validated in F-22 flight tests, and data was used to correlate flight information and aircraft performance with pilot physiological outputs.
- Versatile: Because of its unique design and innovative sensor technology, PUMA can be used to ensure astronaut health; detect hypoxia in pilots, divers, and first responders; and help physicians monitor chronic pulmonary disease.
- Fast: The response time of the PUMA technology is 10 milliseconds (ms), as compared to the 80120 ms of competing units. Faster response means more time to react to life-threatening situations.

THE TECHNOLOGY

PUMA represents a major breakthrough in portable metabolic analysis. It is a rugged, compact device that measures human metabolic function at rest, during exercise, in clinical settings, and in extreme environments. Metabolic measurements are a clinically proven method of monitoring cardiovascular health and fitness levels.

The PUMA headgear features NASA-developed sensors that evaluate six key metabolic functions. Specifically, PUMA measures oxygen and carbon dioxide partial pressure in addition to temperature, pressure, airflow, and heart rate. By placing sensors close to the mouth, PUMA can record up to 30 (or more) detailed measurements for each breath. From these measurements, PUMA computes metabolically relevant quantities of oxygen uptake, carbon dioxide output, minute ventilation, respiration rate, and heart rate. With additional software, the device computes heart rhythm, tidal volume, and alveolar and dead-space volumes. A small embedded computer controls and acquires data from all sensors at 10 hertz (Hz), performs calculations, and transmits data wirelessly to a remote computer. The PUMA sensors are low power, stable, and capable of operating in a range of environments, including very high and low pressures as well as high- and low-oxygen environments. This portable device provides real-time measurements that are just as accurate as the large stationary metabolic carts used in hospitals. PUMA can be used not only in clinical settings but also in the extreme/remote environments of space, aviation, underwater, and deep underground. Because it detects real-time dangerous drops in oxygen, it can ensure astronaut cardiovascular health; predict the onset of hypoxia in pilots, divers, and first responders; and advance chronic pulmonary disease monitoring and athletic training.

PUMA can detect hypoxia in divers

PUMA can monitor health in firefighters

APPLICATIONS

The technology has several potential applications:

- Health monitoring (hypoxia, extreme conditions)
- First responders
- Military
- Commercial space
- Wearables
- Health and wellness

PUBLICATIONS

Patent No: 11,129,546

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NASA's Technology Transfer Program pursues the widest possible applications of agency technology to benefit US citizens. Through partnerships and licensing agreements with industry, the program ensures that NASA's investments in pioneering research find secondary uses that benefit the economy, create jobs, and improve quality of life.

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More Information

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