

Evaluation of LN₂ dewar health using a weight-based monitoring system

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Problem

Fertility clinics use liquid nitrogen (LN₂) dewars (vacuum-sealed tanks that hold cryogenic specimens) to store important biological samples such as sperm and embryos. LN₂ is necessary to hold these specimens at a maximum of -135°C to preserve sample viability indefinitely. All dewars exhibit LN₂ leakage due to imperfect seals and sample handling. This off-gassing of LN₂ means clinics must periodically monitor dewars every 2-7 days and refill the tanks with new LN₂. This is a manual process taking up to an hour per week overall and necessitates high compliance from staff. Failure occurs when temperature gets too high and is a consequence of poor monitoring and management.

Market

There are about 480 U.S. fertility clinics, each with at least 12 dewars that each hold up to 2,000 samples. The cost of liability due to specimen loss is extremely high since specimens represent and limit the customer's reproductive potential. Recent lawsuits resulted in payments of up to \$350,000 per individual affected. LN₂ dewars are also heavily used in industrial manufacturing, research, medical cryogenics, and even cooking. In 2015, these sectors constituted a large market segment worth nearly \$3 Billion USD. Dewar users need better solutions to the high-cost risk of sample loss and liability. There exists a strong and growing market for improved safety and monitoring tools.

Solution

To help fertility clinics and labs that store biological samples reduce liability, our team developed a system to continuously monitor sample viability. The system is comprised of the following:

- Specialized scales that automatically and continuously collect the weight of each dewar. A digital scale is built into a roller-base that functions while the dewar is in use.
- A simple user interface for clinic managers to observe & analyze failure risk for each dewar. Key indicators are evaporation rate and overall weight which are used to quantify performance, predict when a dewar will empty, and stratify risk across employees and customer segments.

Competition & Innovation

There is no industry standard for LN₂ alarms or monitors. Current monitoring systems merely check whether the temperature is viable; while the direct indicator of failure is temperature, any amount of LN₂ above the minimum threshold results in the same temperature. This means failure occurs abruptly. Weight is a more accurate, novel metric that directly corresponds to the volume of LN₂ remaining, giving clinics time to prevent failure. Existing devices can detect LN₂ level, but cannot provide continuous information nor analyze risk of failure.

Testing and Validation

Our system was able to accurately measure weight of various objects within 5%, and detect a 10% change in an evaporation rate dataset within an hour after intentionally altering experimental conditions to change the rate. Expected rates were found experimentally by measuring evaporation of currently-used LN₂ dewars in conditions of normal use and simulated failure using commercial scales. Our client also validated the robustness and accuracy of the system in his fertility clinic, and will use the system.

Commercialization

This viability and compliance monitoring system reduces the time and energy needed to perform manual checks and analyze recorded data. Potential failures are more easily detected, which reduces the chance of failure and thus overall liability. The user interface is accessible to users and manufacturer to help analyze product performance. Ultimately, the system helps safeguard against failure and facilitates more effective monitoring and maintenance by saving time, energy, and cost. 3 other lab administrators have expressed interest in purchasing the system for their labs.