NANOVET ™ : NANOTECHNOLOGY FOR THE MANAGEMENT OF VETERINARY WOUNDS

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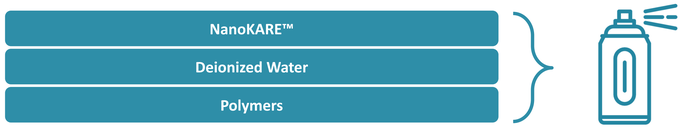
Abstract

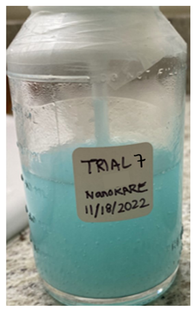
The use of nanomaterials in the wound care industry has gained traction in recent years due to their ability to accelerate and promote wound healing, particularly in the face of growing concerns about antibiotic resistance. NanoTess has developed a non-toxic proprietary composite nanomaterial, NanoKARE™, which has been proven effective in pathogen elimination. BioCertainty has engineered a veterinary-specific wound care aerosol spray called NanoVET™, which is composed of NanoKARE™, Deionized water, and polymers. BioCertainty has successfully developed a prototype formulation of NanoVET™, and determined viability on the veterinary wound care market.

Product Formulation



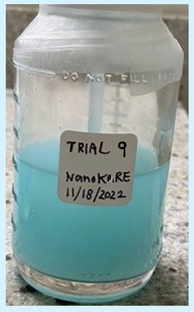
List of Evaluation Properties, Common Ranges for Aerosol Sprays, User Requirements, and Testing Methods.

Property	Common Ranges	User Requirements
Drying Time	0 to 5 minutes	Adequate drying time to avoid product being displaced from the animal's skin.
Dispersion	Even and easy dispersion.	Product covers the entire surface of the wound. User can spray solution from a safe distance.
Odor	Odor diminishes within 2 minutes.	Minimal odor is required to reduce irritation to skin, nose, and throat.
Viscosity	< 0.19 Pa·s	Viscosity is adequate to maintain appropriate adherence to the wound.
Density	< 1.25 g/mL	Solution has adequate density to be dispersed in an aerosol formulation.
pH	6 to 8	pH of product is within the average pH range of the skin of dogs, cats and horses.



MVP #1, 91.11 wt% DI water.

MVP #2, 91.26 wt% DI water.



MVP #3, 90.97 wt% DI water.

Ideal Solution

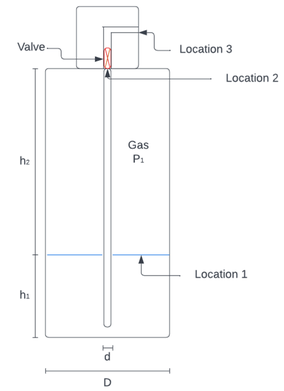
Most Viable Product (MVP) Testing

Based on the evaluation properties and testing, MVP #3 was chosen as it was the solution with the highest viscosity that was able to be discharged in an aerosol format.

Aerosol Can Specifications

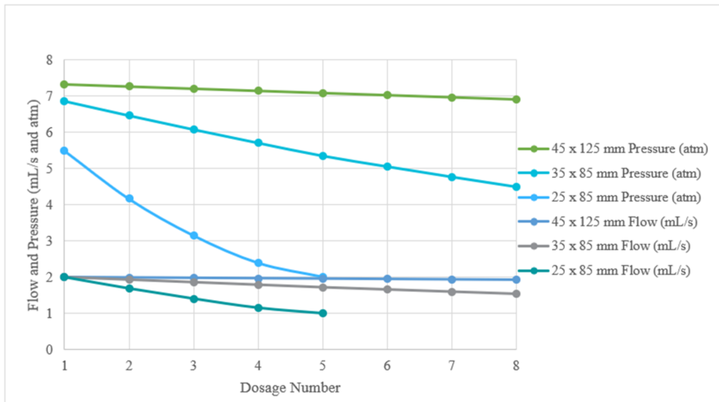
An aerosol delivery method was chosen for NanoVET due to its ease and cleanliness of application for users. A simulation of an aerosol can system was completed using the modified Bernoulli Equation to determine pressure and can size requirements.

The Bernoulli equation was selected as the governing equation for the system. This equation is valid for incompressible fluids and accounts for energy losses due to viscous effects and flow modifications, such as bends and changes in diameter.



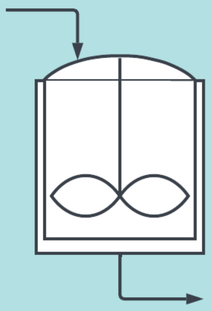
Aerosol Can Schematic

$$P_2 = \rho g\left(h_1 + \frac{V_1^2}{2g} + \frac{P_1}{\rho g} - h_2 - \frac{V_2^2}{2g} - f\frac{h_2 - h_1}{d}\frac{V_2^2}{2g} - \sum K_L\left(\frac{V_2^2}{2g}\right)\right)$$



Pressure and Flow Rate as a Function of Dosage Number Obtained from Bernoulli Simulation for Different Can Dimensions.

Process Overview



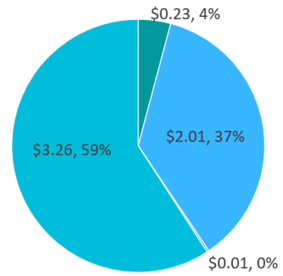
Previously, Bio Certainty proposed a continuous process with three batch mixing vessels. To optimize this process a new design has been developed which consists of one large batch mixing vessel. This will allow for each of the steps of the production process to occur in one location. Additionally, running the operation in batch better meets the production needs of NanoVET™ due to the time required for each mixing step.

Economics and Market Viability

Manufacturing Cost/Unit

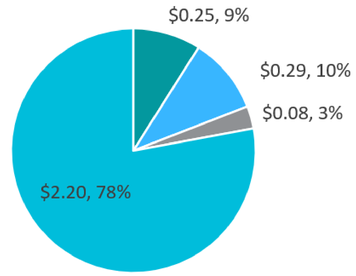
$5.50

Lab Scale Production—6 kg/day



$2.82

Pilot Plant Production—40 kg/day



Cost/Unit to produce NanoVET™ Gel
Fixed Costs/Unit
Cost/Unit to package NanoVET™ Gel
Capital Depreciation/Unit

Safety and Environmental

- **Biocompatibility testing**
- **Packaging labels**

Lot number, user directions, expiry date, sterility, adverse effects, precautions, storage, and product volume

- **Occupational health and safety**

PPE, safe chemical handling

- **Device history records**
- **Regulations including:**

Canada's Hazardous Products Regulations (SOR/2015-17) and CGSB-43.123

- **Life cycle assessment of aerosol can**

Steel cans vs alternatives and recyclable packaging

- **Disposal of waste material**

Conclusion

BioCertainty successfully formulated NanoVET™, and confirmed that an aerosol delivery is viable through prototyping. Acceptable can sizes and pressure specifications have been identified and verified by simulation. The manufacturing process has also been optimized by moving from three separate mixing vessels to one single homogenizing mixer.

The adjustments to the manufacturing process have significantly reduced capital cost, and have allowed for a large increase in production volume from 6 kg to 40 kg per day.

With a per unit manufacturing cost of $2.82, NanoVET™ is well poised to enter the market with a competitive pricing model.