NASA Phase II Project Summary

NONPROPRIETARY

Firm: Creare Incorporated
Contract Number: NNX10CB10C
Project Title: Compact, Efficient, and Reliable Ventilation Fan for EVA Suits

Identification and Significance of Innovation:

The overall objective is to enable routine extravehicular activity during space exploration missions by developing a space suit ventilation blower that meets requirements for long-duration exploration missions. The ventilation blower circulates ventilation gas through the suit pressure garment, liquid cooling and ventilation garment, and portable life support system components that remove CO_2, moisture, and heat. The blower must meet challenging requirements for head/flow performance, low power consumption, compact size and light weight, excellent oxygen safety, low speed, and high reliability.

Technical Objectives and Work Plan:

The objective of Phase II was to design and build a prototype fan using an innovative regenerative design, then demonstrate by test that it is suitable for use as a space suit ventilation fan. The blower must generate 2.7 in. H_2O pressure rise at a flow rate of 4.7 actual ft^3/min at rotating speeds that are low enough for good oxygen safety. The blower must produce this flow rate while operating in pure oxygen at a pressure of 4.3 psia. We created a fluid dynamic design for high efficiency based computational fluid dynamic calculations with extensive experimental validation. All materials used in the blower were selected for oxygen safety. We designed and built a unique motor that isolated the windings from the suit ventilation gas to eliminate a potential fire hazard. We ran extensive tests to measure the blower's operating characteristics and efficiency. We built a test facility to demonstrate operation of the blower under conditions that simulated operation in a space suit portable life support system. We observed and measured the blower's response to dust ingestion in an oxygen environment and showed the capability to produce the flow rate needed for buddy mode operation at low speed.

Technical Accomplishments:

We validated our CFD calculations by measuring the head/flow characteristics and aerodynamic efficiency of candidate impeller designs and comparing the results with results of CFD calculations. We used CFD to create an efficient blade design for the blower that achieved 43% aerodynamic efficiency. The blower demonstrated the ability to achieve the head/flow performance required for space suit ventilation at low rotating speed (5,300 rpm). We ran the blower in a life-test facility in which it circulated pure oxygen at 4.3 psia in an ambient vacuum environment. The blower operated safely in the oxygen loop for over 1,300 hours with no degradation in head/flow performance. The final bearing set operated for over 800 hours in pure oxygen with no sign of wear. The final blower design consumed 8.3 W of power while running at the nominal design point. The blower achieves buddy mode flow rate at a rotating speed of 9,570 rpm. We showed that the blower operates safely through a dust ingestion test without oxygen conflagration and with no effect on head/flow performance.

NASA Application(s):

The regenerative blower is an oxygen safe device that can generate a relatively high pressure rise using a single, low-speed impeller. Applications include ventilation for life support systems used in future space suits and manned spacecraft.

Non-NASA Commercial Application(s):

The efficient, low-speed blower can provide ventilation flow for personal cooling systems needed for military and industrial personnel that must wear protective garments in hot environments.

Name and Address of Principal Investigator:
Michael G. Izenson, Ph.D.
Creare Incorporated
P.O. Box 71
Hanover, NH 03755

Name and Address of Offeror:
Creare Incorporated
P.O. Box 71
Hanover, NH 03755