THE F-16 HALON TANK INERTING SYSTEM

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Abstract

The F-16 multimission fighter employs a new lightweight approach towards providing fuel tank inerting. The F-16 inerting system stores and effectively distributes Halon 1301 (bromotrifluoromethane) to the air space above the fuel level to provide a nonexplosive atmosphere within the fuel tanks when activated. Background information includes a trades study with alternate inerting concepts. Resolution of component and system development problems is discussed and engine and airframe compatibility testing as well as system level tests are detailed. The results of initial F-16 operating experience is highlighted and a projection is made towards future applications. It is concluded that halon fuel tank inerting is a viable candidate for tactical and strategic aircraft weapon systems.

Introduction

The United States Air Force has actively pursued lightweight aircraft fuel tank inerting concepts as a means of improving flight safety and reducing aircraft vulnerability during combat operations. A number of concepts including vapor enrichers, dry ice inerting, active extinguishing systems, exhaust gas inerting and chemical reactor systems have been explored in the past. A comparatively simple gaseous nitrogen system was applied to the F-86 and F-100 aircraft; neither system was used operationally. The F-86 system weighed 116 pounds and provided 8.8 minutes of purging at 35,000 feet for both fuel tanks and fuel tank cavities. The F-100 system weighed 42 pounds and provided 35 minutes of purging at 20,000 - 30,000 feet for fuel tanks only. Requirements for fuel tank inerting became firmly established as a result of the staggering aircraft losses in the Southeast Asia (SEA) conflict. Thousands of fixed and rotary wing aircraft were lost due to enemy groundfire ranging from .30 caliber small arms fire to large anti-aircraft artillery (AAA) to surface-to-air missiles. Analysis indicates that fuel system fire and explosion was the major cause of aircraft losses due to ballistic impacts.

In 1968 an expedited effort to modify various aircraft with a reticulated polyurethane foam filler material was pursued by the Air Force. The foam is installed within the fuel tanks and prevents an explosion by removal of energy from the combustion process through absorption of heat and mechanical interference. Large numbers of several types of aircraft including the F-105, C-130, and F-4 were modified. However, the majority of these aircraft did not reach service in SEA until near the end of the conflict.

Present day attitudes towards aircraft survivability are that the fuel system design, (fuel tanks) must be protected. The latest technology in defense concepts for fuel tank inerting encompass several types of reticulated foam fillers, liquid nitrogen inerting systems such as deployed on the C-5A and halon tank inerting. Halon tank inerting is a relatively new technique for explosion protection of aircraft tankage, although halons have been used as fire extinguisher agents for some time. This concept has been fully developed by the USAF and the General Dynamics Corporation, Fort Worth, Texas, and deployed on the F-16 airplane. The purpose of this paper is to describe the developmental history and initial operating experience of the F-16 system.

Background

Properties of Halon 1301. Halon 1301 (bromotrifluoromethane) is a colorless, odorless gas with a chemical formula of $CBrF_3$. The military specification is MIL-B-12218. It is a highly effective fire extinguishing agent with widespread commercial and military application for protection of electrical hazards, engines, ordinary combustibles and liquid and gaseous flammable materials. Normally, Halon 1301 is compressed for convenient storage and shipped as a liquefied gas. The liquid density is 13.1 lbs/gallon at 70°F. It is a low-boiling substance with a freezing point of -270°F and a boiling point of -72°F at 1 atmosphere pressure. The variation of vapor pressure with temperature is shown in Figure 1. The mechanism by which Halon 1301 acts as a fire suppressant is not fully established. One theory is that CF_3Br chemically interferes with the combustion process.[1] As a chemical change to the hydrocarbon/air mixture occurs with the introduction of an ignition source, complex transient combustion products are formed. The Bromine (Br) radical that is freed during thermal decomposition of Halon 1301 is considered to react with these transient products and interfere with the intermediate combustion process to halt the development of an explosion. A relatively small amount of Halon 1301 is needed to produce this effect.

Halon 1301 is the safest extinguishing agent currently available with an Underwriters' Laboratory (UL) rating of 6 (least toxic group classification). Numerous animal tests and actual human exposures have demonstrated this low exposure and inhalation toxicity. Because of the low toxicity, Halon 1301 has found widespread application for protection of inhabited areas.

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