The Analyses of 45-Degree Bunsen Burner Test and Oil Burner Test for Cargo Liners

Shuang Wu*, Zhengye Lv, Kun Ding, Weixing Huang, Gen Li, Zhenguang Hou, Junfei Ni, Yichun Ke, Hongzhai Huang

Comac Shanghai Aircraft Design & Research Institute

*Corresponding author e-mail: 18745291863@163.com

Abstract. Since the last century, the challenges caused by fire prevention of cabin and cargo compartment materials were increased year by year. As one of main part for cabin and cargo compartment materials, the flame penetration resistance ability of cargo liners was become a research focus. However, the 45 degree combustion test and oil burner test (which were used to test flame penetration resistance ability of the cargo liners) are quite similar in experimental scale and experimental conditions, which can cause great trouble for the research of the flame penetration resistance ability of cargo liners. Thus, the differences between 45 degree combustion test and oil burner test were discussed in this paper.

1. Introduction

The development of civil aircraft industry is an important embodiment of a country's development. For the development of civil aircraft industry, the problem of flight safety has been widely concerned by researchers. Due to fast propagation speed and difficult to control, fire has become a major threat to the flight safety of civil aircraft. It has been reported that, in the past decades, the fire in civil aircraft cabin has caused great casualties and property losses. Therefore, it’s important to do the fire inspection work before the materials used in aircraft.

Cargo liner as one of the most important part of civil aircraft cabin, it is important to detect its burn-through resistance ability. At present, the flame penetration resistance ability of the cargo liner is test by 45 degree combustion test and oil burner test. In the past decades of development of fire tests on materials for civil aircraft cabins, the 45 degree combustion test and oil burner test have been deeply investigated. But, the differences between them were never investigated. For example: in the Aircraft Materials Fire Test Handbook (which was published by FAA), the 45 degree combustion test and oil burner test were all defined as to test flame penetration resistance ability of cargo liner, and the samples for test were all required as cargo liner. Which can bring a lot of misunderstanding for test and may leading to the confused in the test process.

Thus, in this paper, the differences between 45 degree combustion test and oil burner test in research scope, test conditions, test parameters, test instruments and sample selection were investigated, which expect to give some suggestions for researchers.
2. Differences for the Tests

2.1. Research Scope differences
45 degree combustion test and oil burner test were all carried to investigate the burn-through resistance ability for cargo liner, but the 45 degree combustion test was carried to test the burn-through resistance ability of all cargo liner materials, the oil burner test were carried to investigate the burn-through resistance ability for finished products. It is indicated that, 45 degree combustion test was the material level experiment, which is the most basic test to investigate the burn-through resistance ability for cargo liner; oil burner test was the finished product level experiment, which is carried test the burn-through resistance ability for cargo liner before it is used in aircraft. For the cargo liner materials, after through the 45 degree combustion test, oil burner test can be carried on it.

2.2. Equipment differences
The 45 degree combustion test must carried in calm condition, the bunsen was selected as burner, the equipment for 45 degree test is shown in Fig. 1. The oil burner test must carried in open space, the spray gun burner was selected as burner, the equipment for oil burner test is shown in Fig. 2. These indicated that, the 45 degree combustion test is the closed test, oil burner test is the opened test.

![Figure 1. Experiment for 45 degree burner test](image1)

![Figure 2. Experiment for oil burner test](image2)
2.3. Fuel and Flame Differences
The fuel for 45 degree combustion test was the methane, the inner flame height of the burner was 22 mm, the outer flame height of the burner was 38 mm, the inner flame temperature of the burner must higher than 843 °C. The foil for oil burner test was the fuel oil, the burner must provide high strength and open flame, the inner flame temperature of the burner must higher than 871 °C. These indicated that the oil burner test applied stronger flame on sample.

2.4. Flame Exposure Time and Flame Distance Differences
The exposure time for 45 degree combustion test was 30 s, the distance between sample and burner was about 25 mm, the exposure time for oil burner test was 5 min, the distance between sample and burner was about 203.2 mm. These indicated that the oil burner test required longer exposure time, the distance between sample and burner was longer.

2.5. Sample differences
The sample size for 45 degree combustion test was required about 254 mm×254 mm, the sample size for oil burner test was required about 406 mm×610 mm. It is indicated that the sample size for 45 degree combustion test was smaller than oil burner test.

2.6. Test Result Requirement Differences
The 45 degree combustion test and oil burner test were all required the flame must not penetrate any sample during the test process. However, except require the burn-through resistance ability for cargo liner, 45 degree combustion test was also carried to evaluate the smoldering ability and flame burning ability, it require smoldering time less than 10 s and flame burning time less than 15 s; oil burner test was also carried to evaluate the temperature of the back of sample, which require the temperature of the back of sample less than 204 °C.

3. Results
In this paper, the differences between 45 degree combustion test and oil burner test was discussed. The 45 degree combustion test was the material level experiment, the oil burner test was the finished product level experiment; the equipment for 45 degree combustion test belong to closed test and the equipment for oil burner test belong to open test; the flame exposure time of 45 degree combustion test was much shorter than oil burner test; the sample size for 45 degree combustion test was smaller compared with oil burner test; the test result requirement has a huge difference. Thus, the researches need to distinguish the 45 degree combustion test and oil burner test carefully.

References
[1] Benenson T. Sixty Years of Safe Flight[J]. 2007.
[2] Richard E. Lyon, Natallia Safronava, James G. Quintiere. Material properties and fire test results[J]. Fire & Materials, 2014, 38.
[3] Bobbie Rogowski. A critique of the fire test methods used to assess individual products involved in the Artane fire[J]. 7(3):213-225.
[4] Tran K D. Burn-through resistance of fibre/felt materials for aircraft fuselage insulation blankets (p 1-6)[J]. 2010, 26(1):1-6.
[5] Sarkos, C.P, Spurgeon, J.C, Nicholas, E.B. Laboratory Fire Testing of Cabin Materials Used in Commercial Aircraft[J]. Journal of Aircraft, 16(2):78-89.