INVESTIGATION OF ROTATING PYROTECHNICAL DECOY IN REALISTIC AIR FLOW WITH AUTHENTIC IGNITION

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Abstract

Protection of military aircrafts requires effective decoys as a countermeasure against heat seeker guided missiles. Preservation of the effectiveness of pyrotechnical decoys needs continuous improvement to compensate sensor evolution.

For the assessment of decoy properties it is essential to conduct investigations in conditions close to operational decoy firings. For this purpose Fraunhofer ICT built a test facility that imitates realistic flow velocities, enables the application of the original ignition sequence and simulates the tumbling motion of a burning decoy body. The applied method is a simple and economic way to characterize essential properties of new decoy compositions in an early state of development.

This paper presents the current state of the ICT test facility for spectroscopic investigations of burning pyrotechnical decoys.

1. Introduction

Novel infrared seeking sensors can provide detailed spectral resolution in multiple bands. This enables the guiding system to discriminate between the actual target and the ejected decoy. Hence one of the most important requirements for new pyrotechnical decoys is to imitate a spectral band ratio that is similar to the natural signature of the platform they protect. [1, 2]

Furthermore there are additional characteristics that play an important role to the success of a decoy’s mission. Besides a reliable ignition pyrotechnical decoys must have a short rise time to a sufficient high level of radiation.

The early characterization of real-sized flares in terms of their effectiveness under operational conditions is an important part of the development process. Of course the best way are field tests with aircrafts ejecting pyrotechnical decoys. But due to the fact that these experiments are expensive and complicated to perform they should be reserved for the final proof of effectiveness.

Fraunhofer ICT uses a test facility with a variable air stream to simulate almost realistic flow conditions for fixed decoy firings. The decoy masses must be fixed in position to achieve high grade optical measurements. In order to obtain an authentic time scale it is necessary to preserve the original ignition sequence. In its current state the facility is equipped with a rotating mount to simulate the tumbling motion of a decoy after ejection. This mount also enables to adjust the initial orientation of the decoy on its rotational axis to simulate different eject angles.

2. Experimental

As presented in a previous paper [2] the directed air stream is produced by opening a system of preloaded air vessels. This system provides a variable air flow that simulates eject profiles of helicopters, transporters and jet planes for the duration of several seconds. The decoy samples are fixed in the centre of the air flow.

Due to the application of the original ignition in this test facility [3] the decoy masses must be fixed with pins passing the ammunition shell through a narrow slot. By firing the squib the shell takes off. Although the mechanical ejection process is inverted, all the important ignition effects take place in an identical way.

The new rotation device consists basically of an electric motor, a magnetic brake and a telescopic support for the sample holder. The rotary drive is controlled by the computerized test facility control system. Figure 1 shows a sketch of the rotation device.

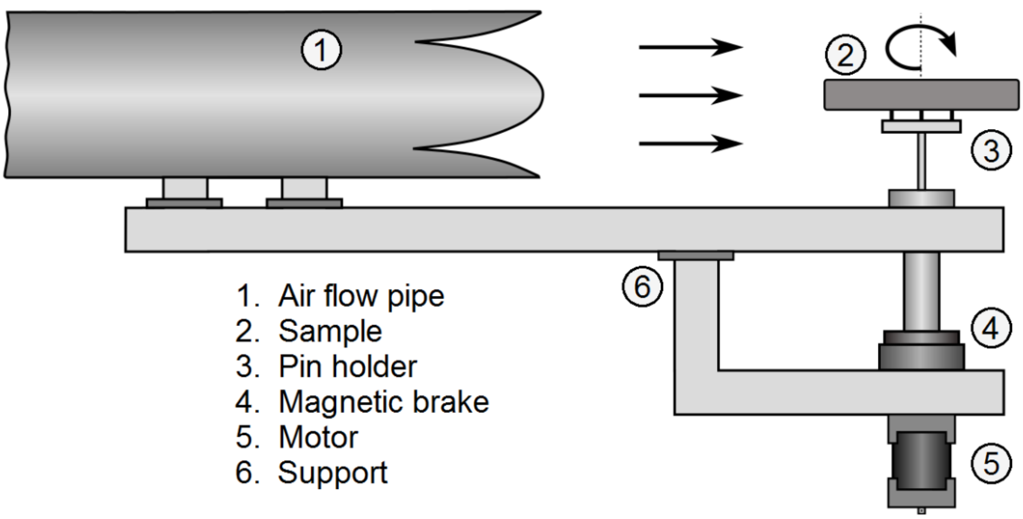
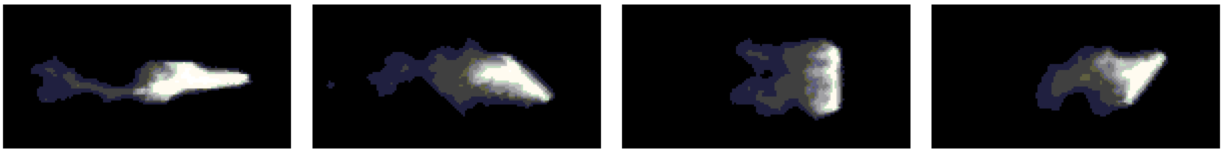


Figure 1: Sketch of the rotating mount

3. Test results

The first tests were conducted with common 1x1x8 inch MTV-type flares at an initial air flow velocity of approximately 180 m/s. Only the ammunition shell was modified to insert pins for fixing the decoy mass. The initial orientation position of the decoy was coaxial to the air flow direction. The rotational axis was in horizontal orientation and parallel to the optical axis of the measurement systems. The rotation starts 1 s after ignition with 120 revolutions per minute (2 Hz).

The frames in figure 2 illustrate a sequence of infrared images showing the burning flare in rotation.



t = 1000 ms | t = 1125 ms | t = 1250 ms | t = 1375 ms

Figure 2: IR-images of a rotating 1x1x8 flare burning in air flow

As a consequence of the rotation in fast air flow condition the burning decoy emits modulated radiation. The strength of this effect depends on velocity and orientation of rotation axis. Figure 3 shows an intensity plot of a rotating flare burning under jet condition. The rotation axis is vertical and perpendicular to the view aspect This orientation results in a strong modulation of radiation intensity.

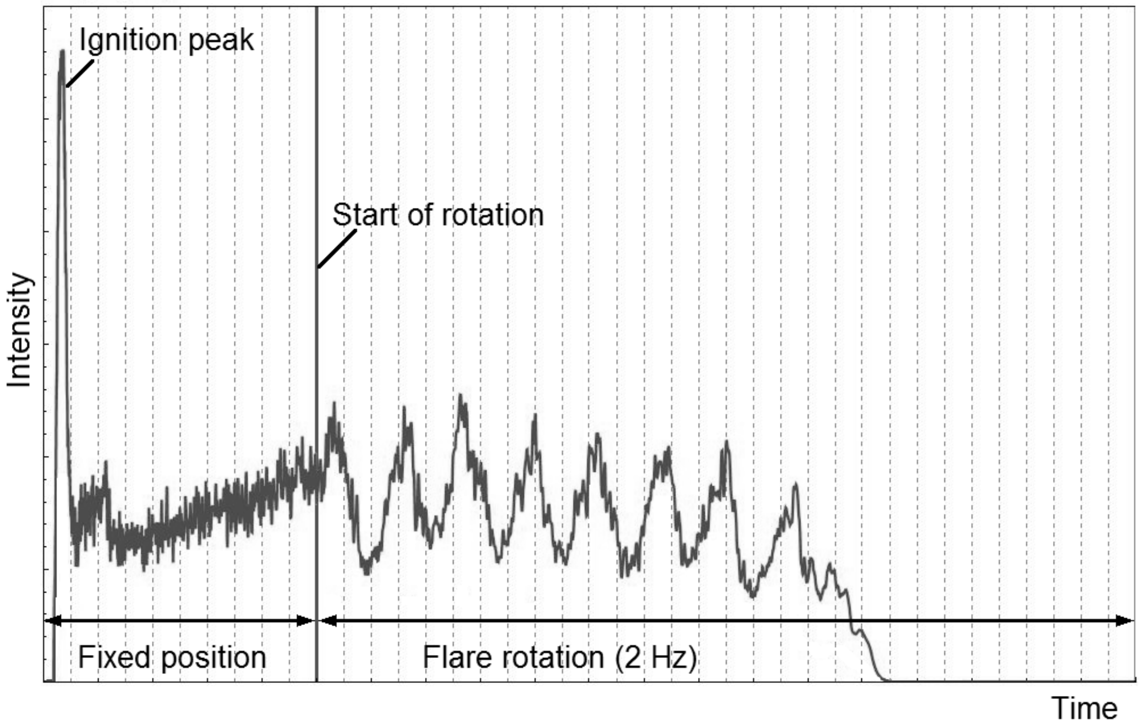


Figure 3: Intensity plot of burning pyrotechnical decoy in fixed and rotating state

4. Discussion

As expected rotating the decoy inside the air flow has a serious impact on the emitted radiation intensity and depends on factors such as the velocity of the air flow, the orientation of the rotation axis as well as the chemical and geometrical characteristics of the decoy mass.

Tests have shown that the modulation of intensity increases with the air flow velocity. In addition a perpendicular orientation of the rotation axis to the observation direction leads to stronger modulation than in case of coaxial orientation. Also a weak burning decoy composition is stronger affected by these air flow effects. Over all the geometrical shape is crucial for modulation intensity. In particular the rod-shaped decoy flares like the used 1x1x8 inches types show a strong modulation that would not be expected from ball-shaped decoys.

5. Summary

Since the real tumbling motion can have a substantial influence on the effectiveness of pyrotechnical decoys the Fraunhofer ICT test facility for flares was enhanced by a mount which drives the burning decoy to rotation at a fixed position.

This test facility for pyrotechnical decoys provides now an almost realistic air flow, the use of the original ignition sequence and simulates the tumbling motion of an ejected flare. Furthermore this rotating device can be used to set any initial angle in which the decoys will be launched from aircrafts.

Having access to such a test facility that can recreate operational conditions and give fast results that can be compared to real decoy firings makes an important contribution to speed up the development of new pyrotechnical flare compositions for aircraft protection.

6. References

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