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Research Article

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Studies of influence on the physicochemical properties of jet fuel by *Aspergillus penicillioides*

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ABSTRACT

Aspergillus penicillioides as one of the main contaminating fungi in jet fuel has been identified. In order to study the influence of A. penicillioides on the the physicochemical properties of jet fuel, two BH-fuel system were established. Contrary to the control group, in the positive group the A. penicillioides has been cultivated. Then the physicochemical properties of the two system were compared after cultivation. And the result shows that the A. penicillioides will obviously affect the appearance, water separation index, particle size and acid of the jet fuel. On the contrary, freezing point, flash point, density and water reaction of jet fuel has no significant change. Meanwhile, A.penicillioides could lower the thermal oxidation stability of jet fuel while enhancing its corrosion..

Key words: *Aspergillus penicillioides*; Jet fuel; Physicochemical properties

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INTRODUCTION

Microbial contamination will result in many damage which caused huge economic losses. Aviation and oil sectors at home and abroad has conducted in-depth research on microbial contamination in jet fuel for many years [1,2]. For example, IATA has released the "Guide for Microbial Contamination of aircraft fuel tanks material" and ASTM has published "Standard guide for microbial contamination in fuels and fuel systems" which proved analysis and suggestion to the problems caused by microbial contamination in aircraft fuel tank and the ground fuel supply system[3,4]. Research results indicated that the main reason for microbial contamination in jet fuel is the presence of moisture. Moisture may enter jet fuel by different routes. Especially for strategic fuel reserve, since the reserve time would be several years or even decades. Therefore, that will contribute to the presence of moisture water and microbial contamination[5]. Microbial contamination could lower the quality of jet fuel, clogged filter separator and threat to flight safety. The "mud" produced by Microbial contamination could corrode tanks, pipelines and storage tanks[6-8]. Gaylarde (1999) has summarized previous work and indicated that fungal contamination as one of the main microbial contamination would result in many problems [9]. A. penicillioides as one of the main contaminating fungi in jet fuel has been identified at the previously work by the next-generation DNA sequencing (NGS) techniques. But its influence on physicochemical properties of jet fuel has not been reported.

This paper will evaluate the influence on physicochemical properties of let fuel by application of experiments according to the National Standard of the People's Republic of China. Meanwhile, the thermal oxidation stability and corrosive of jet fuel were also be evaluated.

EXPERIMENTAL SECTION

Fungi sample and its cultivation

A.*penicillioides* (CGMCC) used in this study was provided by the China General Microbiological Culture Collection Center. Each BH-Fuel medium composed by 50ml jet fuel and the 100ml BH. The jet fuel should been filtrated by 0.22 μm filter membrane befor added into the BH medium which has been sterilized at 120℃ for 20min. Then the positive BH-Fuel medium numbered A was inoculated A.penicillioides,therefoer, the other BH-Fuel medium was the control group numbered B. The two BH-Fuel medium were cultivated at 25℃ for 30d. The composition of BH agar shown in Table 1.

Table1: The composition of BH agar

Ingredients	Gms / Litre
Magnesium sulphate($MgSO_4$)	0.2g
Calcium chloride($CaCl_2$)	0.02g
Monopotassium phosphate(KH_2PO_4)	1.0g
Dipotassium phosphate($(NH_4)_2HPO_4$)	1.0g
Ammonium nitrate(KNO_3)	1.0g
Ferric chloride($FeCl_3$)	0.05g

Determination of the Physicochemical properties

After the cultivation, the physicochemical properties of jet fuel in the two BH-Fuel medium was test according to the instructions of National Standard of the People's Republic of China (GB). The indexes and its standard determination methods involved in this experiment were shown in the Table 2.

Table 2 Physicochemical index and standard determination methods

	Density	Acid	Flash Point	Copper corrosion	Water reaction	Water separation index	Freezing point
Method[10-16]	GB/T 1884-2000	GB/T 12574-1990	GB/T 261-2008	GB/T 5096-1985	GB/T 1793-2008	GB/T 11129-189	GB/T 2430-1981

Thermal oxidation stability test

The thermal oxidation ability of each jet fuel sample was tested by Petro Oxy RSSOT Apparatus (Anton Paar, Austria) according to the manufacturer's instructions. The test condition is 700 kPa, 180℃. The induction period of jet fuel in this test is defined as the time when the pressure drop of 10 % comparing to the maximum pressure. The induction period could indirectly reflected the oxidation stability of the jet fuels.

Particle size test

The particle size was tested by TP791 Oil Particle counter (Beijing Timepower Measure and Control Equipment Co.,ltd ,china) according to the manufacturer's instructions. The particle degrade divided according to the National Associate standard (NAS) 1638.

A3 steel corrosion test

After the cultivation, two A3 steel were hanged into the two BH-Fuel medium respectively for 15d. Then took out the steel and observed its corrosion. The steel should immersed by the oil-water interface.

RESULTS AND DISCUSSION

Appearance

The appearance of the two BH-Fuel system which have cultivated for 30d were shown in Figure 1.In accordance with standard, the qualified jet fuel should be clear and without solid particles and other insoluble substances at room temperature. It can be founded in Figure 1 that the appearance of control system is colorless and transparent which is in line with product standards. On the contrary, there has a biofilm formation at the oil-water interface of A medium while the water-in-oil substances has been produced. Therefore, the appearance of positive system obviously do not meet the standards.

A B

Fig.1 Appearance of the jet fuel

Physicochemical index

Water separation index, acid value, density, water-reactive, flash point, freezing point and other physical and chemical parameters of jet fuel were measured and the results shown in Table 3. It is shown that water separation index and acid value of jet fuel were obvious affected by A.penicillioides, while, density, water reaction, flash point, freezing point and copper corrosion index has no significance change.

Tab.3 Physicochemical index of jet fuel

	Density /(kg·m^{-3})	Acid /(mg·g^{-1})	Flash point/□	Copper corrosion	Water reaction	Water separation index	Freezing point/□
A	793.1	0.141	44	1b	1b	93	-67
B	791.4	0.012	45	1a	1	82	-65
Standard index	775~830	≤0.015	≧48	≤1	≤1	≧85	≤-47
Method	GB/T1884-2000	GB/T12574-1990	GB/T261-2008	GB/T5096-1985	GB/T1793-2008	GB/T11129-189	GB/T2430-1981

Thermal oxidation stability

The induction period of each fuel sample has been determinated by the Petro Oxy RSSOT Apparatus, and the result were shown in Figure 2. In Fig.2, we could found that the induction period of A medium was significantly lower than B. Therefore, the growth of A.penicillioide could significantly weaken the oxidation stability of jet fuel.

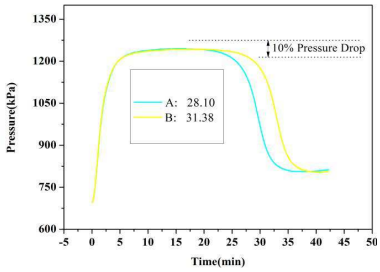

Fig.2 Induction period of the two jet fuel samples

Particle contaminating level

The particle size of solid particles and other insoluble substances in jet fuel was determinated by TP791 Oil Particle counter, and the grade of particle contaminating was divided according to the NAS 1683 shown in the Table 4. From the table, we could see that the particle size contaminanting level of jet fuel which contaminated by A.penicillioide is much larger than the control group. The grade of the particle contamination of jet fuel has increased from 6 to 9,while, the particle counts of 5 ~ 15 μm size has increased 10-fold from B to A. All the results indicated that the growth process of A.penicillioide in jet fuel will produce insoluble substance, such as biofilm which could be seen in Appearance section, etc .

Tab.3.2 Comparison of the particle pollution

		5-15 μm	15-25 μm	25-50 μm	50-100 μm	＞100 μm	Final Grade	Standard
A	Particle count	12764	423	64	14	2	9	≤8
	Grade	9	7	6	4	7		
B	Particle count	1014	740	93	28	0	6	
	Grade	5	5	6	4	0		

Corrosion of the A3 steel

Took out the A3 steel from the BH-Fuel medium after hanging for 15d and the corrosion result was shown in Figure 3. From the Fig.3 we could see that both A3 steel has been corroded by the system, but the corrosion level of steel in A medium (Fig.3 b) was larger than the one in B (Fig.3 b). Meanwhile,the interface corrosion of steel could be observed by optical microscope (Fig.4). The biofilm would adhere to the interface of the steel during corrosion process and that will be accelerate the corrosion in turn.

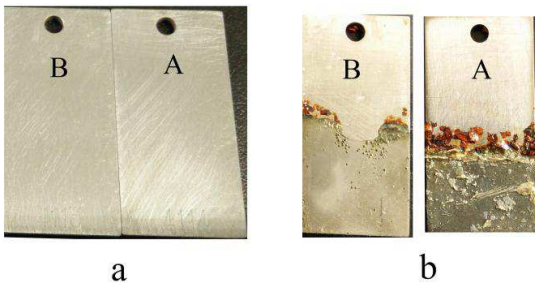

Fig.3 Interface corrosion of steel in BH-Fuel medium

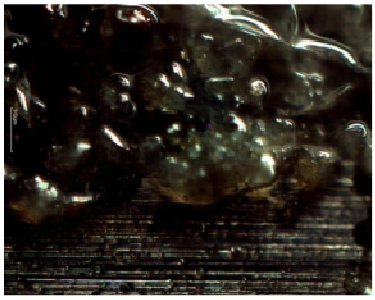

Fig.4 Biological membrance under the optical microscope

CONCLUSION

This paper established two BH-Fuel system to study the the influence on the physicochemical properties of jet fuel by A.penicillioides. The results indicated that the appearance, water separation index, particle size, thermal oxidation stability and acid value index of jet fuel which inoculated with the A.penicillioides has significance change, while, density, water-reaction, flash point, freezing point and copper corrosion were almost stable.

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