INCINERATOR FOR FIAMMABLE RADIOACTIVE WASTES

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ABSTRACT

An incinerator was built up in 1987 in Shanghai. In this paper, the devices of the incinerator, main parameters of the process, the results of combustion tests for non-radioactive waste and simulated radwaste are given. The instructive information for radwaste treatment were provided.

Keywors: Flammable radioactive wastes Incinerator Collection efficiency Decontamination efficiency

I. INTRODUCTION

Incineration of flammable radioactive wastes is the most effective way for reduction of radwaste volumes. On the basis of the first prototype a new incinerator was built up in 1987 in Shanghai.

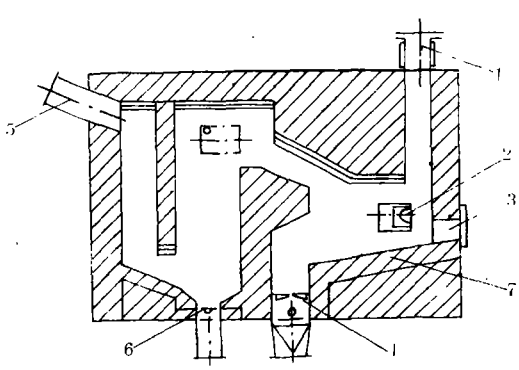

Fig.1 Furnace structural representation

1. Feed pipe 2. Burner hole 3. Push rod hole 4. Tipping grate 5. Flue tube 6. Tipping grate 7. Sloping hearth

1. The synopsis of radioactive wastes incinerator

The incinerator consists of four parts: combustion system, cleaning system, control system and ventilation system.

1) Loading equipment The 50 L waste drums are carried by handcarts into the workshop. The waste bags are taken out of the opened drums with the combustion chamber.

2) Incinerator It has two chambers, a primary combustion chamber and a secondary chamber for further burning up. The furnace is built with firebricks. The primary combustion chamber is

separated from the secondary by a bridge- wall. The structural representation is given in Fig.1. Two low pressure oil burners of RK type are used to maintain the proper temperatures for these two chambers.

3) Ash removal equipment The ashes move down along the sloping hearth to the grate at the back of the primary combustion chamber. The grate can be tipped. The ashes are evacuated through the grate into the heat exchanger- mixer. After cooling the ashes pass through the tipping valve and are put into plastic bags.

2. Cleaning system

The off- gas clean- up system consists of five parts.

1) Cyclone scrubber of CX type It has high efficiency and low resistance loss.

2) Pipe electrostatic precipitator The non- uniformity of high voltage electric field makes flue gas ionization. Dust was deposited on the pipe wall of the collecting electrode under effect of electric field. The system has two electric fieleds connected in series. Most of dust particles are removed in the pipe electrostatic precipitator.

3) Heat exchanger It is a water- jacketed condenser. It can protect HEPA filter material from burning out.

4) HEPA filter It is a filter box of GB- 01 type filled with glass fibre, 99.9% of the dust particles and aerosols with the sizes of more than 0.3 μm can be removed.

5) Stack It is 30 meters high. The cleaned off- gas is discharged to the atmosphere.

The flow diagram of the incinerator is given in Fig.2.

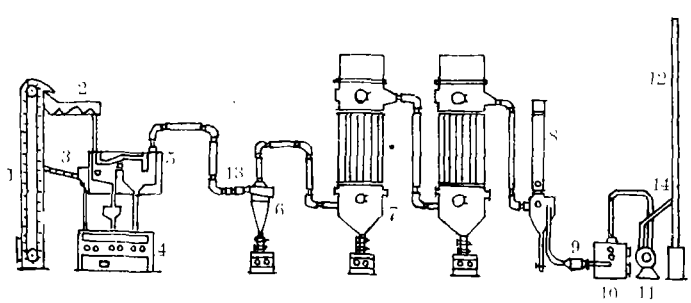

Fig.2. Flow diagram of radioactive wastes incinerator

1- Elevater *2*- Level feeder *3*- Mechanical push rod *4*- Operation box *5*- Furnace *6*- Cyclone scrubber of CX type *7*- Pipe electrostatic precipitater *8*- Heat exchanger *9*- Electric hearter *10*- HEPA filter *11*- Fan *12*- Stack *13*- Inlet sample point *14*- Outlet sample point

3. Control system

There is an intercommunication between the central control room and other stations. The operation of each part of whole incinerator is controlled by the central control room, such as, *a*) adjustment of the high voltage power of the pipe electrostatic precipitator; *b*) adjustment of the loading intervals; *c*) observation and

automatic recording of the temperature and negative pressure at each monitoring point of the combustion and cleaning systems; *d*) selection of the travel length of the push rod; *e*) changing- over of hand- operated and automatic manner in loading process, etc.

4. Ventilation system

The ventilation system of incinerator workshop is divided into three parts. *a*) ventilation of the central control room, an injection ventilation. *b*) ventilation of the incinerator hall, an exhaust ventilation. *c*) ventilation of the ash removal operational box and ventilation chamber, also an exhaust ventilation. Each part has it's own separated air- blower to avoid the cross contamination.

II. TEST CONDITIONS

1. Treatment capacity: 50 kg/h.

2. Waste package: 1 kg/pack.

3. Temperature range: 850—950°C for primary combustion chamber. 900—1000°C for secondary combustion chamber.

4. Furnace vacuum: - 10 to - 20 mm H_2O.

5. Off- gas volume: 1500m^3/h.

6. Subsidiary fuel (light diesel oil): 10 to 30 L/h.

7. Pipe electrostatic precipitator: output voltage is 40 kV. Current intensity: 25 to 30 mA.

III. TEST FOR EFFICIENCY OF INCINERATOR

Two kinds of tests were performed for detecting incineration effeciency of radio-

Table 1

Collection efficiency of cleaning system of the incinerator

No.	Dust concentration at inlet (mg/l)	Dust concentration at outlet (mg/l)	Collection efficiency (%)
1	5.0×10^{-2}	1.0×10^{-3}	96.0
2	18.0×10^{-2}	1.2×10^{-4}	99.8
3	4.6×10^{-2}	1.0×10^{-3}	95.6
4	5.6×10^{-2}	3.7×10^{-4}	99.0
5	11.6×10^{-2}	1.2×10^{-3}	98.0
6	10.9×10^{-2}	2.5×10^{-4},;	99.6
7	13.0×10^{-2}	1.2×10^{-4}	99.8
8	5.4×10^{-2}	1.2×10^{-3}	95.0
9	11.4×10^{-2}	1.2×10^{-3}	98.0
	Mean collection efficiency		97.8

active wastes. One is for non- radioactive wastes and the other for labelled radioactive ones. A mixed flammable waste was made up according to various kinds of

radioactive wastes in Shanghai. One kg waste per pack contained 25% paper, 20% plastic, 25% cotton, 10% rubber and 20% wood chip. The operation conditions were the same as mentioned above.

1) Test of non- radioactive wastes Wastes packed in polyethylene bages were loaded into the combution chamber with a rate of 30- 60 kg/h. The filter film was used to sample at each monitoring point according to the principle of isokinetic sampling. The results were given in Table 1. The mean collection efficiency for the cleaning system was 97.8% . The discharge dust concentration was 1.2×10^{-4} to 1.2×10^{-3} mg/l (or 0.12 to 1.2 mg/m^3).

2) Test of labelled radwastes The operation conditions were the same. In the simulated wastes, 18.5×10^6 37×10^6 or 55.5×10^6Bq/kg of ^{32}P were added respectively. The results were given in Table 2. The mean decontamination efficiency was 99.93%. The discharged radioactive concentration was $(3.3 \text{ to } 10.4)\times10^{-4}$Bq/1.

Table 2

The simulated combustion test of ^{32}P labelled waste

No.	Activity of inlet cleaning system (mg/l)	Activity of exhaust gas (mg/l)	Decontamination efficiency (%)
1	0.63±0.01	(5.2±0.56)×104,;	99.83
2	2.66±0.04	(4.8±0.67)×10^{-4}	99.96
3	3.26±0.07	(4.4±0.62)×10^{-4}	99.97
4	1.44±0.04	(4.1±0.56)×10^{-4}	99.94
5	0.74±0.03	(3.3±0.59)×10^{-4}	99.90
6	0.48±0.01	(4.4±0.45)×10^{-4}	99.81
7	2.78±0.004	(10.4±0.09)×10^{-4}	99.92
8	12.21±0.11	(6.7±1.0)×10^{-4}	99.99
9	11.47±0.15	(4.4±0.93)×10^{-4}	99.99
10	5.18±0.07	(4.4±0.45)×10^{-4}	99.98
11	1.67±0.04	(7.8±1.07)×10^{-4}	99.90
	Mean collection efficiency		99.93

$n\% = (1- C_e \cdot Q_e/C_i \cdot Q_i)\times100\%$ (used for Tab.1 and 2)

C: Concentration *Q:* Wind volume i: Inlet e: Exhaust

IV. CONCLUSION

The simulated tests of ^{32}P- labelled radwastes proved this incinerator equipped with double combustion chambers and multiple cleanup stages is quite safe and can be used to treat the urban low- and intermediate level flammable radwastes without environmental contamination.