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Characterization of the process of household waste processing in the optimized wet combustion reactor

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Fundamental arrangement of the reactor

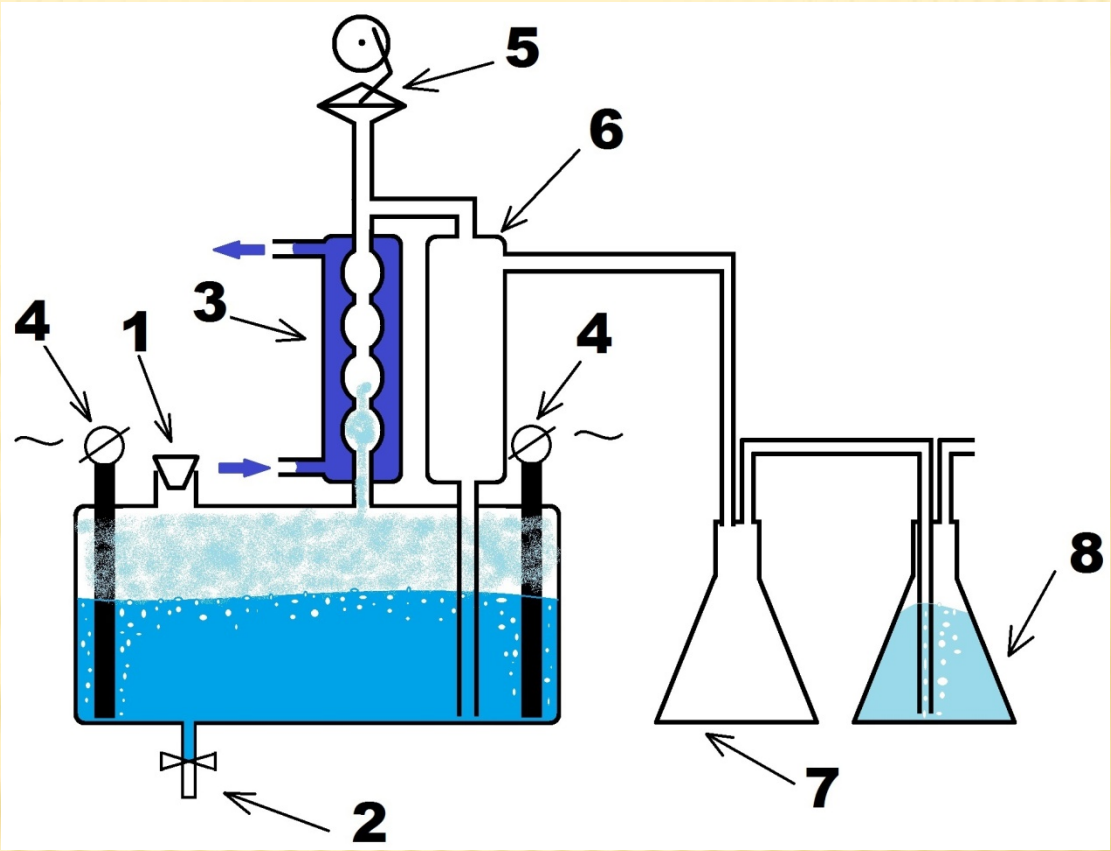


Fig. 1. Fundamental arrangement of the reactor:
1 - lid and aperture for wastes inserting; 2 - confluent valve; 3 - water cooler; 4 - electrodes; 5 - device to bowl down the foam; 6 - volume for foam excesses taking; 7 - additional volume for avoiding acid and mineralized solution mixing; 8 - volume for NH_3 fixation.

Introduction

Household waste:

- **cotton waste - cellulose towels, gauze, and medical cotton (1:1:1) – 162 g/day/person**
- **graywater - washing off soapy water after dirty dishes – 3 l/day/person**

Purpose: **to find conditions optimal for wet combustion of household waste and estimate process characteristics (duration, energy, etc.)**

Requirements to the process: **minimal H2O2 consumption, energy consumption, minimal duration of process, acceptable degree of oxidation (> 60 %), no trace amount of H2O2 in products.**

Method

Step I

Variants of household waste wet combustion:

1) **combustion of cotton waste;**
2) **combustion of graywater;**
3) **combustion of graywater & cotton waste mixture.**

- **various amount of H_2O_2;**
- **combustion with HNO_3 (*direct aqueous solvent of cellulose*);**
- **combustion with urine + H_2O_2 (*urea is reactive aqueous solvent of cellulose*);**
- **combustion with human metabolites + H_2O_2;**
- **combustion with different electric current voltages**

Method

Step II

Variants of configurations for the wet combustion reactor:

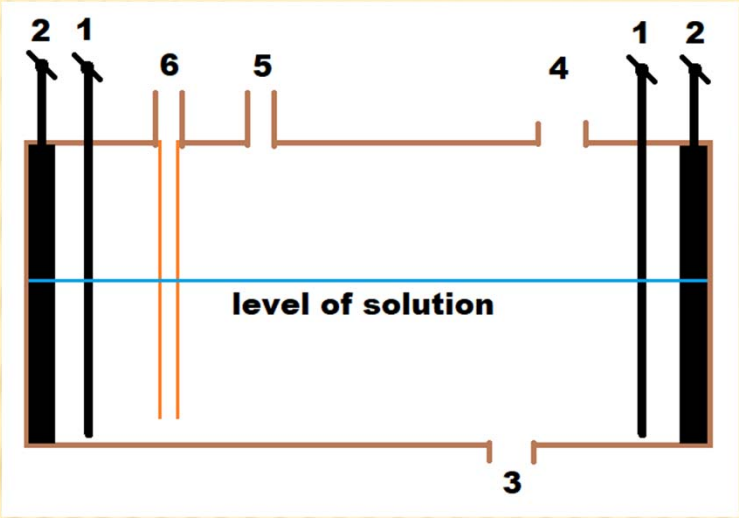


Fig. 2. Horizontal orientation

1) bar electrodes; 2) flat electrodes; 3) confluent valve; 4) aperture for wastes inserting; 5) aperture for connection with water cooler; 6) aperture for connection with volume for foam excesses taking

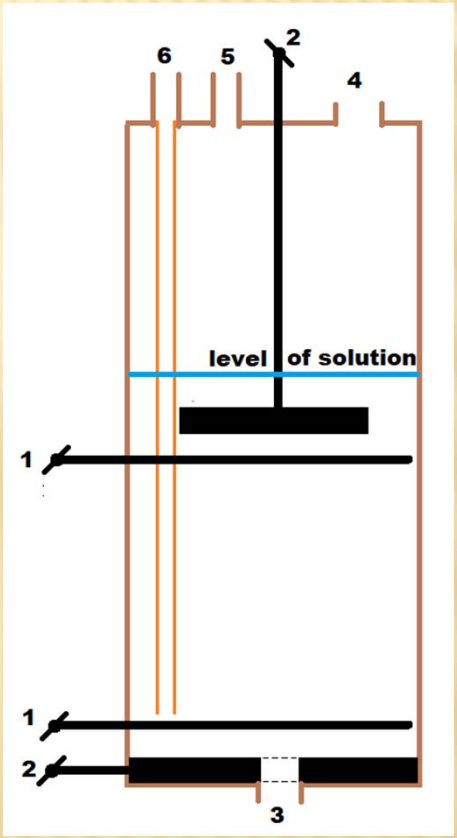


Fig. 3. Vertical orientation

Results (Step I)

- **Separate graywater oxidation has no perspectives**

- **H_2O_2 (36 %) consumption – 16 ml/g cotton waste, 50 ml/l graywater**

Table 1. Comparison of “best” variants.

Variant	Duration, h	Energy cosumption, kW·h/l	Total degree of oxidation, %	Cotton degree oxidation, %
"+HNO_3"	7.3	5	65-79	70
“cotton + urine"	14.3	7	96	69
“cotton + graywater + urine"	8.3	3	61.5	72

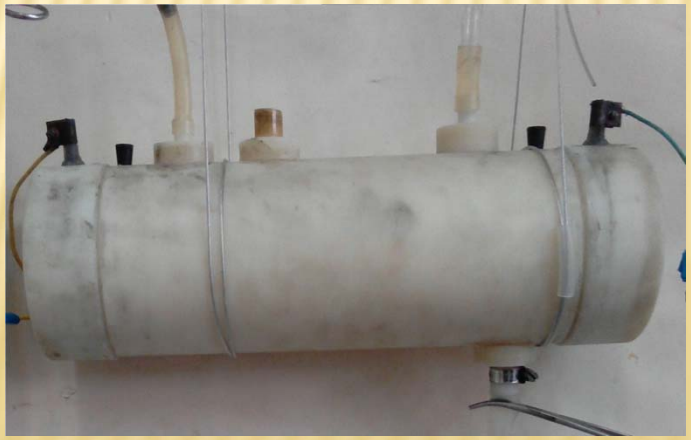
Results (Step I)

Table 2. Mineral composition of wet combustion treatment (cotton waste + urine).

	NH4+	N_{total}	NO3-	K	Na	Ca	Mg	P	S	Fe
Solution, mg/l	505	1658	133	365	736	9,80	6,67	96	131	0,11
Sediment, %	-	1.46	-	1.35	2,58	0,52	0,20	0,86	0,47	0,02

Results (Step II)

Combustion in reactors of different configuration:



Results (Step II)

Table 3. Efficiency of processing of sanitary and household cotton wastes.

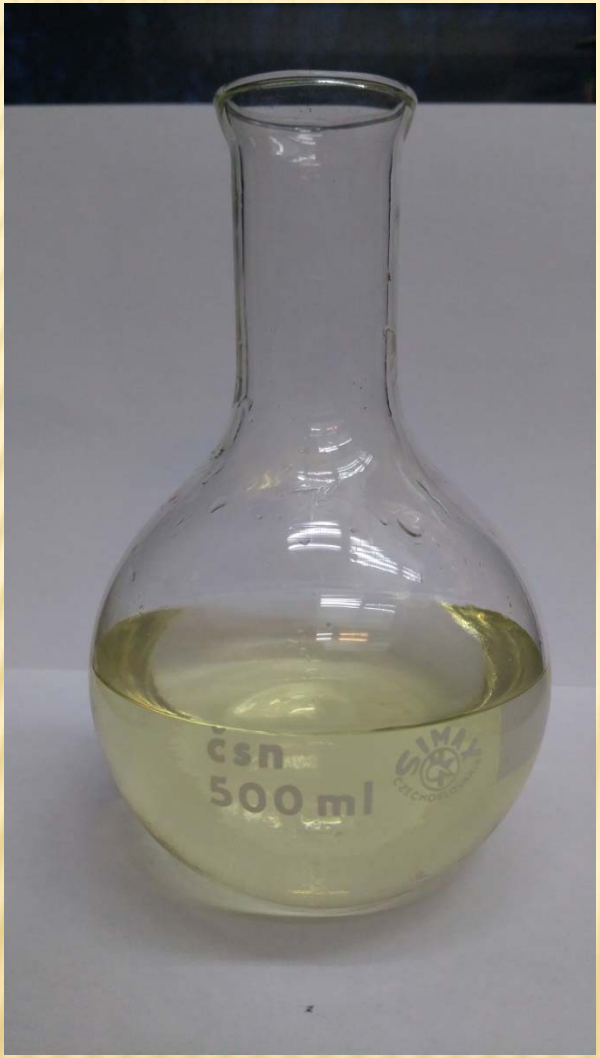
Reactor config.	Duration, h	Energy consumption, W·h/l	Energy consumption, W·h/g*	Degree of oxidation, %
“Horizontal, bar electrodes"	11	2300	115	51
“Horizontal, flat electrodes"	5.5	1720	86	47
“Vertical, bar electrodes"	13	2950	150	61
“Vertical, flat electrodes"	11.5	413	21	66

Results (Step II)

Table 2. Mineral composition of wet combustion treatment (cotton waste + graywater + urine).

	NH4+	N_{total}	NO3-	K	Na	Ca	Mg	P	S	Fe
Solution, mg/l	510	4735	88	346,2	450	5,13	7,028	93,06	162,2	0,092
Sediment, %	-	3,706	-	0,56	6,83	0,26	0,04	0,27	0,26	0,01

Results (Step II)



Results (Step II)

Table 4. Volume and composition of released gases.

Components of released gases	Reactor orientation	
	horizontal	vertical
O2, %	86	87,5
CO2, %	12,3	10,6
H2, %	0,4	0,6
NH3, %	0,03	0,03
NO, ppb	40	40
NO2, ppb	60	60
CO, %	1.3	1.3
Volume, l (from 1 l of solution)	114	128

Next efforts

Using the reactors products in plant growing:

- **Checking the possibility of mineralized solution usage in plant growing on neutral substrate;**

- **Checking the possibility of sediment usage in plant growing on soil-like substrate**