ARCHIVES
of
FOUNDRY ENGINEERING
Published quarterly as the organ of the Foundry Commission of the Polish Academy of Sciences

ISSN (1897-3310)
Volume 10
Special Issue 2/2010
119 – 122

22/2

The possibilities of the microwave utilization of wastes on the example of materials containing the asbestos

M. Pigiel[a,*], **K. Granat**[a], **D. Nowak**[a], **W. Florczak**[b], **M. Stachowicz**[a]
[a] Foundry and Automation Group, Wroclaw University of Technology, ul. Łukasiewicza 5, 50-371 Wrocław, Poland
[b] FLORMO Sp. j., ul. Strumykowa 39, 58-500 Jelenia Góra
* Address for correspondence: miroslaw.pigiel@pwr.wroc.pl

Otrzymano 20.05.2010, zaakceptowano do druku 05.06.2010

Abstract
The presented paper introduce some of the results of the investigations in the utilization of the materials containing asbestos in the existing in Wroclaw University of Technology Institute's of Technology of Machines and the Automation Foundry and Automation Group the microwave reactor. In the reactor's heating chamber there is possible to recycle from 3 up to 5 kg of the batch at once. The temperature with which is possible to receive in it is approx. 1400 ^{o}C. The time of it's achievement (in dependence from utilized material) can take out from 25 up to 40 minutes.

Key words: Environment protection, Utilization, Microwave reactor, Asbestos.

1. Introduction

The investigations of the utilization of materials containing the asbestos were conducted in the microwave reactor exercised by the Wrocław company "PROMIS" for commissioning the Institute's of Technology of Machines and the Automation Foundry and Automation Group. The construction of the reactor was described in Fig. 1 and his view is shown in Fig. 2.

After opening the upper cover (Fig. 2.) the mixture of asbestos and a substance, which intensifying the process of heating, was placed inside the reactor (dielectric pipe). The reactor is holding regulations of the power of heating. The maximum power of the heating is approx. 2.1 kW. The process of heating proceeded dynamically and after about 30 minutes the temperature inside the reactor's chamber was above 700 ^{o}C. The temperature inside the chamber of the reactor was measured constantly through the tube mounted in the upper cover of the reactor, which dimensions were under critical (Fig. 2.).

For the temperature measurement was used Raytek with the measuring scope from +200 to 1400^{o}C.

2. The investigation of the effectiveness of the utilization process of materials containing the asbestos

In Fig. 3 was shown the interior of the microwave generator after turning the power supply off (temperature in the local areas increase to 1200 ^{o}C). However, in Fig. 4 was shown the batch in the chamber of the microwave reactor directly before the extraction of the material outside.

Fig. 5 demonstrate utilized material after cooling and before cutting and grinding down.

The structure of correctly degraded material is porous, it resembles the structure of pumice (see Fig. 6).

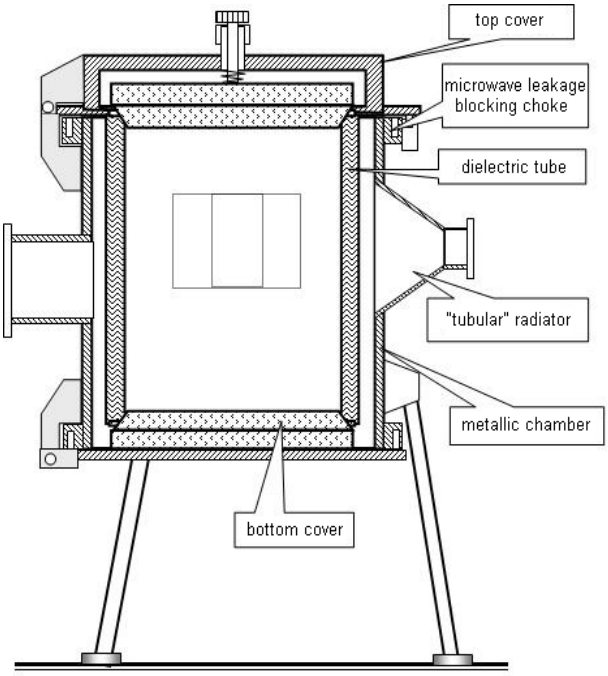

Fig. 1. Layout of the microwave reactor

Fig. 2. The view of the reactor chamber with installed generators

Fig. 3. The view of the interior of the microwave reactor's chamber after the short-lived batch heating - visible pieces of plates of the asbestos-cement roofing material

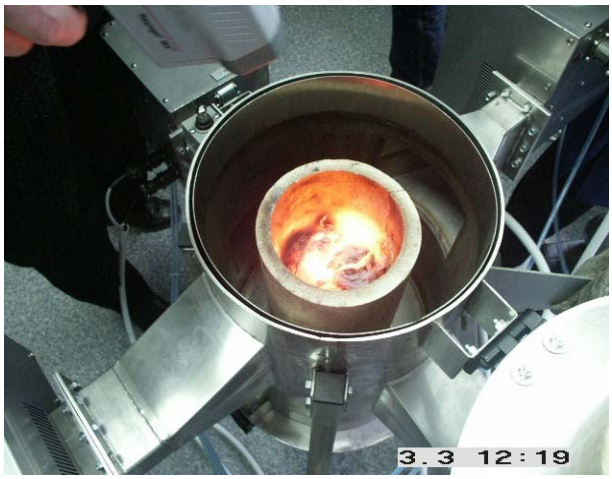

Fig. 4. The view of the interior of the microwave reactor's chamber after the complete batch overheating – visible areas of the melt batch

Microscope observation of grinded down material taken from the many places of the burnt through sample (conducted according to the procedure applied in preliminary examinations on the stereoscopic microscope at enlarging 25 x) occurrence of the fibrous structure in all taken to investigations grinded down samples of recycled material wasn't affirmed.

Fig. 5. The view of burnt through sample after cooling before cutting and grinding down

Fig. 6. The view of the of material after utilization process and cutting

Fig.7. Asbestos-cement roofing material neutralized in the microwave reactor with the 1:1 participation of the X substance. Light microscope; enlarging 25:1

In the aim of the unambiguous, ultimate statement of fully conducted process of degradation of the material containing asbestos (asbestos-cement roofing material), grinded down material was taken from many areas into X-ray investigations. Received, example diffractograms from samples before and after the utilization process are shown in Fig. 8 and Fig. 9.

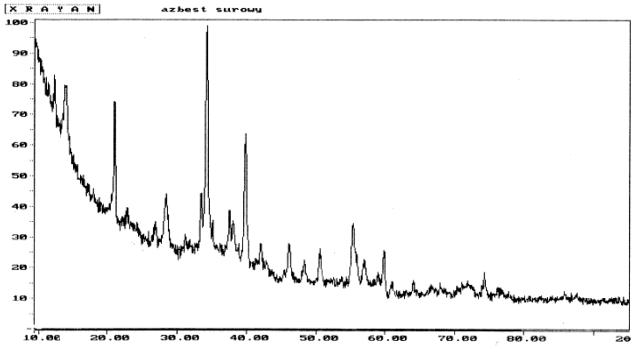

Fig. 8. The view of diffractogram of the sample before the utilization process

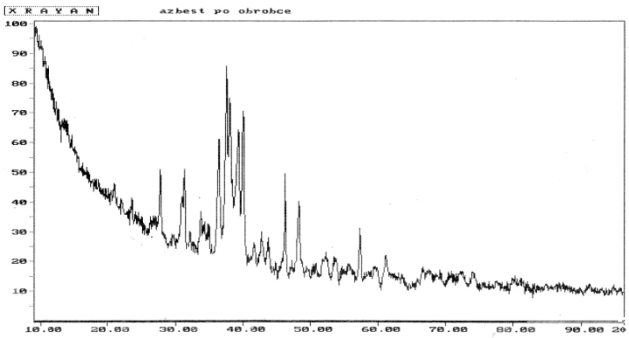

Fig. 9. The view of diffractogram of the sample after the utilization process

Registered diffractograms were analyzed, to the purpose of the phases identification, with use of data included in ICDD cards (International Centre for Diffraction Date).

Analysis of the material diffractogram before the utilization process affirmed the appearing of the following minerals:

a) portlandite $Ca(OH)_2$; ident. number ICDD: 4-733;
b) calcite $CaCO_3$; ident. number ICDD: 24-27;
c) clinochrysotile $Mg_3Si_2O_5(OH)_4$; ident. number ICDD: 27-1275;
d) baumite 1t $(Mg,Mn,Fe,Zn)_3(Si,Al)_2O_5(OH)$; ident. number ICDD: 29-704.

It has been noticed, that the asbestos-derivative mineral clinochrysotile was unambiguously identified (Fig. 8). Possible is appearing of other minerals (aluminosilicates), which are covering already identified lines (e.g. the nickel can appear instead of magnesium in chrysotile) or their pikes are too weak and it isn't possible to appoint them in the background of the record.

The presence of portlandite and calcite is connected with binding material applied to the production of plates of asbestos-cement roofing material.

Analysis of the materials diffractograms after the utilization process affirmed the appearing of the following minerals:

a) larnite Ca2SiO4; ident. number ICDD: 33-302, 9-351;
b) combeite Na4(Ca,Al.,Fe)3Si6O16(O,H,F)2; ident. number ICDD: 25-800;
c) clinochrysotile $Mg_3Si_2O_5(OH)_4$; ident. number ICDD: 27-1275.

The presence of clinochrysotile, which attesting of asbestos appearing wasn't confirmed. The strongest lines originating from this mineral (Fig. 9), particularly line at d = 7.35 Å, don't have an independent pike, and the appearing track of these lines can equally well come from the current in the sample mineral combeite.

3. Conclusions

1. The microwave heating utilization process of substances containing asbestos fibres is possible.
2. For every kind of substances containing asbestos should be choose suitable quantity and the type of the material intensifying heating process.
3. The temperature of utilized material containing asbestos should exceed 700 ^{O}C in the whole deposit of the utilized material.
4. The "product" received as a result of the utilization process of materials containing asbestos is entirely safe for surroundings.

References

[1] M. Pigiel, Badania możliwości utylizacji związków zawierających azbest mikrofalami, Archiwum Odlewnictwa PAN, 2004,vol 4, nr 11, t 2, s. 105-110
[2] M. Pigiel, Zastosowanie mikrofalowego nagrzewania w odlewnictwie, Krzepnięcie Metali i Stopów nr 33, Zielina, 1997.
[3] M. Pigiel, K. Granat, D. Nowak, W. Florczak, Wykorzystanie energii mikrofalowej w procesach odlewniczych, Archiwum Odlewnictwa, 2006.
[4] R. Litwin, M. Suski, Technika mikrofalowa, Wydawnictwa Naukowo–Techniczne, Warszawa 1972.
[5] W. Garczyński, Podstawy techniki mikrofalowej, Oficyna Wydawnicza Politechniki Wrocławskiej, Wrocław 2003

Możliwości mikrofalowej utylizacji odpadów na przykładzie materiałów zawierających azbest

Streszczenie

W niniejszym opracowaniu przedstawiono niektóre z wyników badań utylizacji związków azbestu w istniejącym w Zakładzie Odlewnictwa i Automatyzacji Instytutu Technologii Maszyn i Automatyzacji Politechniki Wrocławskiej reaktorze mikrofalowym. W komorze grzewczej reaktora można jednorazowo utylizować od 3 do 5 kg wsadu. Temperaturę jaką można w niej otrzymać to ok. 1400^{o}C. Czas jej osiągnięcia (w zależności od utylizowanej materiału) może wynosić od 25 do 40 minut.