MARZENNA POPEK, D.Sc.,Chem.
Chemistry Department
Gdynia Maritime Academy

Influence of production method of zinc blende concentrate on its parameters determining ability for safe shipment by sea

SUMMARY

In this paper presented are results of testing three types of Polish zinc blende concentrates with taking into account their production method as it significantly influences properties of the concentrates, important from the point of view of sea transport safety.

The test results are thoroughly discussed and concluded that despite the susceptibility to liquefaction of the fine-grained metal concentrates is tightly related to the grain size content, their transportable moisture limit (TML) values mainly depend on a way of their manufacturing.

INTRODUCTION

The most serious hazard associated with the shipment of ore concetrates by sea is a risk of their passing into liquid state in sea voyage conditions [1]. One of the main parameters deciding on their susceptibility to liquefaction is grain size content of a cargo :

- a cargo which contains 10% grains of less than 1 mm in size is qualified as susceptible to liquefaction
- the transportable moisture limit (TML) value increases along with cargo disintegration increasing.

The fine-grained floatation zinc blende concentrates and sintered zinc concentrates produced by Polish mining-metallurgical works are characterized by different physical and chemical properties. It results a.o. from different methods of their manufacturing.

The initial, comparative tests of their parameters important from the point of view of sea transport safety, performed by the Chemistry Department, revealed that :

- the zinc concentrate production method decides on cargo disintegration level : dimensions of grains of the sintered concentrates are much greater than those of the floatation concentrates
- the sintered zinc concentrates, of greater grain sizes, are characterized by greater TML values than it should be expected from their grain size content
- the floatation zinc concentrates, of much greater disintegration, have smaller TML values than the sintered concentrates [2].

Moreover, it is known that the ore concentrates of a disintegration level similar to that of the sintered ones, are characterized by the proneness to water infiltration (possiblility of their liquefaction is this way eliminated), and that the tested (sintered) concentrate intensively absorbes water.

The observed properties of the zinc concentrates have required to be comprehensively assessed and to this end successive laboratory tests to be performed with the use of the fine-grained materials from the mining-metallurgical works in Trzebionka.

The carried out tests have been aimed at providing a basis for assessment of susceptibility to liquefaction of zinc concentrate cargoes in sea transport conditions. The issue is of a great practical importance as the concetrates in question are exported by sea.

TESTING

Tested materials

In the tests the following samples of zinc blende concentrates were used :

- a floatation zinc blende concentrate from the Mining-Metallurgical Works „Trzebionka" in Trzebinia
- a granulated zinc-lead concentrate from the Mining-Metallurgical Works in Bukowno
- a sintered zinc concentrate from the Mining-Metallurgical Works in Bukowno.

Testing methods

The influence of production method of zinc blende concentrate on its parameters determining ability for safe shipment by sea, was assessed on the basis of determination of the following parameters :

- ⇨ specific weight
- ⇨ grain size content (curves of)
- ⇨ the moisture level, with the use of a procedure for evaluating liquefaction potential [3]
- ⇨ flow moisture point of the tested concentrates [4].

A comparative analysis of mineralogical content and floatation additives of the tested samples was also performed.

Test results and their discussion

The obtained specific weight values of all samples are given in Tab.1. The values are necessary for evaluating liquefaction potential and determining the transportable moisture limit (TML) by means of the Proctor C/Fagerberg method.

Tab.1. Specific weight values of the tested concentrates

Sample type	Specific weight [g/cm^3]
Floatation zinc concentrate	4.01
Granulated zinc-lead concentrate	3.95
Sintered zinc concentrate	4.82

The grain size analysis was performed for all tested concentrates. Its results are presented in Fig.1. in the form of the grain size distribution curves.

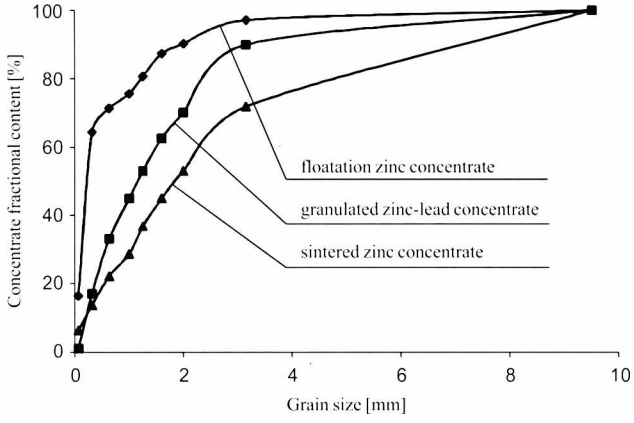

Fig.1. Grain size distribution curves

The course of the grain size distribution curves indicates that all the tested concentrates are susceptible to liquefaction in sea voyage conditions as in each case the content of the grains smaller than 1 mm appears below 10%. The content percentage values of the grains of the size between 0 and 1 mm are equal to respectively.

The values were determined for the fraction of the concentrate with the grains of less than 9.5 mm in size 75.5%, 44.9% and 28.7%, respectively.

The liquefaction potential test was carried out in accordance with the Japanese proposal of evaluating liquefaction potential of solid bulk materials [3]. Its results are presented in Tab.2.

Tab.2. Results of evaluation of soaking degree before and after filtering

Sample type	Moisture level after filtering [%]	Soaking degree of a concentrate [%]	
		Before filtering	After filtering
Floatation zinc concentrate	16.9	98.3	95.6
Granulated zinc-lead concentrate	12.4	95.6	76.3
Sintered zinc concentrate		94.2	77.1

Basing on the values of the soaking degree after filtering one can state that the tested concentrates are susceptible to liquefaction.

The evaluation of the transportable moisture limit was performed with the use of the Proctor C/Fagerberg method, according to the recommendations given in Appendix D to the Code of Safe Practice for Solid Bulk Cargoes [4].

Its results are presented in Fig.2, 3 and 4. The measured values are shown as black spots, and the straight line corresponds to the 70% moisture level values (theoretically calculated).

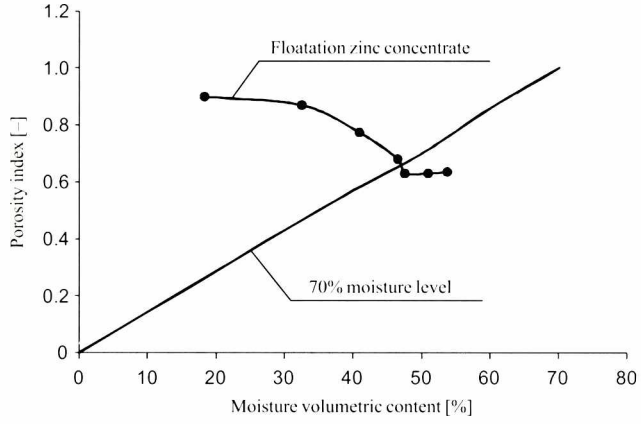

Fig.2. Consolidation curve for the floatation zinc concentrate

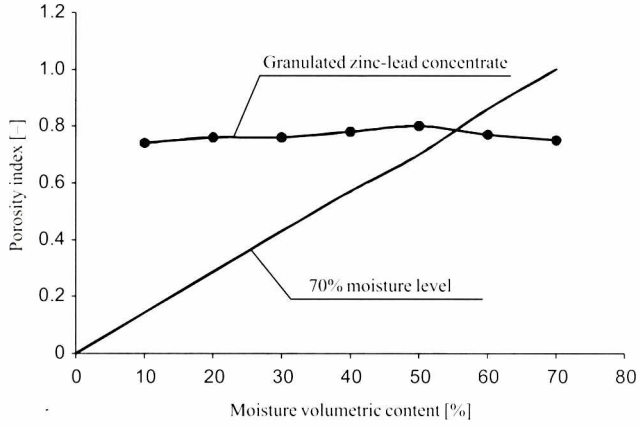

Fig.3. Consolidation curve for the granulated zinc-lead concentrate

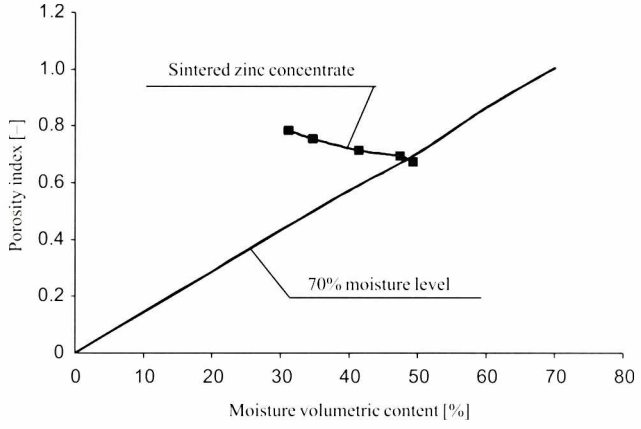

Fig.4. Consolidation curve for the sintered zinc concentrate

On the basis of the performed test the allowable transportable moisture limits (TML) were determined for the tested concentrates. The obtained results are shown in Tab.3.

Tab.3. TML values determined by means of Proctor C/Fagerberg method

Sample type	TML expressed as moisture volumetric content [%]	TML expressed as moisture weight content [%]
Floatation zinc concentrate	45.5	10.8
Granulated zinc-lead concentrate	52.5	11.7
Sintered zinc concentrate	47	8.9

CONCLUSIONS

- Taking into account the water soaking degree of the concentrates after filtering, obtained from the liquefaction potential evaluation test, one can state that all the tested materials are susceptible to liquefaction. Therefore the concentrates should be tested in order to determine their TML values and will be accepted for shipping by sea if their current moisture content is lower than the determined TML values.
- The results of the grain size analysis show that the floatation zinc concentrate is most disintegrated, and the sintered zinc concentrate – most coarse-grained. The effective size D10, i.e. the minimum grain size at which 10% content is obtained, is as follows :
  - 0.063 mm – for the floatation zinc concentrate
  - 0.22 mm – for the granulated zinc-lead concentrate
  - 0.3 mm – for the sintered zinc concentrate.
- Despite the above presented results of the grain size analysis, the TML value of the floatation zinc concentrate is smaller than that of the granulated zinc-lead concentrate. The comparison of the TML values of : the floatation zinc concentrate and the granulated zinc-lead concentrate, as well as of the granulated zinc--lead concentrate and the sintered zinc concentrate, confirms that a correlation occurs between the grain content and TML value; the greater disintegration of a concentrate the greater its TML value.
- TML value mainly depends on a way of manufacturing of the fine-grained metal concentrates in spite of that the susceptibility to liquefaction is tightly related to the grain size content.

Appraised by Stefan Kawiak, Assoc.Prof.,D.Sc.

BIBLIOGRAPHY

1. *Annual Book of American Society for Testing and Materials*. 1997
2. Michałowski Z., Popek M., Sobiecki A.: *Determination of critical and permissible moisture content in fine-grained ore concentrates and similar materials*. Polish Maritime Research, No 3, September 1995
3. IMO: *New procedure for evaluating liquefaction potential of solid bulk materials*. (Submitted by Japan). Sub-Committe on Dangerous Goods, Solid Cargoes and Containers 4/5/5. London, 25 November 1998
4. IMO: *International Maritime Dangerous Goods Code. Supplement D : Code of Safe Practice for Solid Bulk Cargoes*. London, 1998

Conference

ODRA'03

On 28-30 May 2003 the Faculty of Maritime Technology, Technical University of Szczecin, and Wessex Institute of Technology, Great Britain, organized in Szczecin :

5th International Conference on Marine Technology ODRA'03

Since 1995, during the conferences of this kind, generally devoted to maritime technology, as many as 272 papers have been presented, prepared by 498 authors including 252 from Poland and 246 from abroad, who represented the scientific centres of Australia, Brazil, China, Egypt, Hong-Kong, Iran, Japan, Canada, Korea and USA. Thus the conferences has become a broad international forum for exchange of experience and opinions.

The scientific program of this-year Conference contained 31 papers dealing with technical problems of shipbuilding industry, ship operation and water transport, the following in particular:

- design and construction of ships
- ship hydrodynamics
- materials and engineering processes in shipbuilding
- navigation and ship operation
- safety and reliability in maritime technology
- inland waterway transport
- multi-modal transport.

The papers were prepared by 24 authors from Poland as well as 44 foreign authors from Kroatia, Brazil, Iran, Japan, Korea, Spain, Germany, Norway, Turkey, Great Britain and Italy.

The Conference participants had the opportunity of being acquainted with technical facilities and ship repair processes used in the Ship Repair Yard „Gryfia", Szczecin, and of visiting Maritime Museum in Szczecin.

An attractive event varying the Conference meetings was the Slavic music concert and folk band performance, specially arranged for the Conference participants.