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## DEFERRIZATION OF EOLIC SANDS FROM ŠAJDÍKOVE HUMENCE DEPOSIT

**Summary.** The contribution gives attention to the possibility of eolic sands deferrization by means of magnetic separation. The sands from Šajdíkove Humence are treated by classifier. They are utilized in foundry and building industry.

## ODŻELAZIANIE PIASKÓW EOLITOWYCH ZE ZŁOŻA ŠAJDÍKOVE HUMENCE

**Streszczenie.** Artykuł jest poświęcony odżelazianiu piasków eolitowych za pomocą separacji magnetycznej. Piaski z Šajdíkove Humence były wzbogacane w klasyfikatorze. Znajdują one zastosowanie w przemyśle budowlanym i odlewniczym.

Zastosowanie tych piasków w przemyśle szklarskim jest ograniczone przez zawartość żelaza. Próbki piasku były przerabiane w suchej i mokrej separacji magnetycznej o wysokim natężeniu pola w poligradientowym separatorze Jones'a.

### 1. Introduction

Deposit of eolic sands - Šajdíkove Humence is located in Záhorská s bottom land (south-western Slovakia). It is formed by downsands which achieve the thickness about 30 m. The sands are good sorted out ($d_{50}$ = 0.26 mm), with very low content of the fraction under 0.02 mm. The content of grains in the fraction of 0.1 - 0.6 mm attains 93 % meanly [1].

Quartz occurs in the sands as dominant mineral. Its content in light fraction where it is accompanying by feldspar attains over 95 %. The content of heavy minerals such as garnet, hornblende, ore minerals, staurolite, epidote and apatite is not more than 1 % [4].

Eolic sands from Šajdikove Humence are considered to be prospective raw-material for utilization in glass industry. In the past they were used only in building industry. Since 1972 after the putting into operation of water contraflow classifiers the sands are treated to several kinds of foundry sands suitable for the pouring of grey cast iron [1, 2].

The quality of glass sand must fulfil the following conditions: content of $SiO_2$ over 93 % with very low content of $Fe_2O_3$ (for instance - optical glass under 0.02 % of $Fe_2O_3$, white and fine white glass under 0.04 % of $Fe_2O_3$, sheet glass under 0.15 % of $Fe_2O_3$ and mirror glass under 0.2 % of $Fe_2O_3$) [2,4].

Firstly, detailed research on the possibilities of treatment of eolic sands described in [3] was directed to the flotation of feldspar with the following high-intensity magnetic separation. The quartz sand with content of $Fe_2O_3$ under 0.06 % and concentrate with content of feldspar about 76 % were obtained.

Samples marked as S-35 and S-50 obtained by water contraflow classifying were subjected to wet and dry magnetic separation with the purpose to determine the efficiency of both above mentioned ways of separation.

## 2. Grain size analysis

Grain size analysis of samples S-35 and S-50 have been provided by dry classifying on screens. The distribution curves were constructed. They are represented in Fig. 1. The samples contain a very few of fraction under 0.1 mm and they can be characterized by these values of mean grain:

S - 35 $d_{50} = 0.389$ mm S - 50 $d_{50} = 0.625$ mm

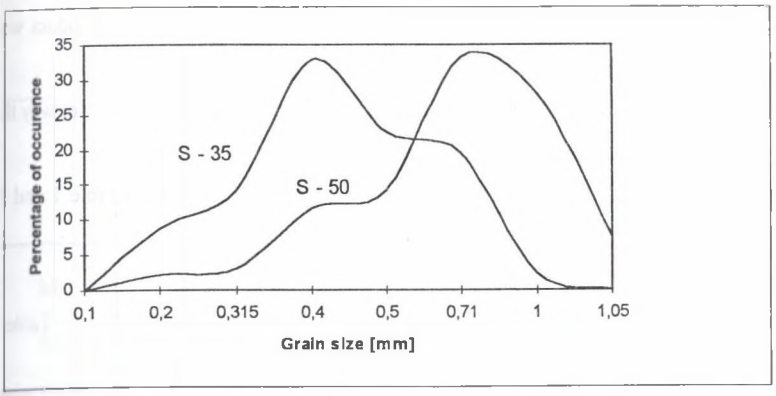


Fig. 1. Grain size distribution curves of samples S - 35 and S - 50
Rys.1. Krzywe składu ziarnowego próbek S - 35 i S - 50

### 3. Magnetic separation of sands

The laboratory separator JONES was used for separation tests. Separation process has been realized in a casket located in an air gap of separator. The basic characteristics of separator is represented in fig. 2 as the dependence of magnetic induction on magnetizing current.

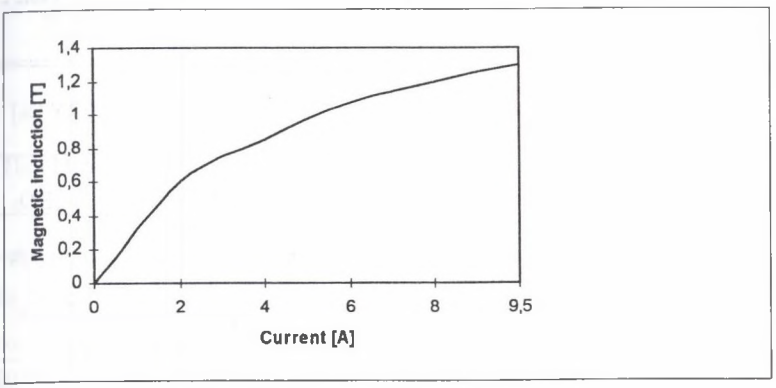


Fig. 2. Dependence of induction on magnetizing current
Rys.2. Zależność indukcji od prądu magnesującego

Wet magnetic separation was realized in the casket filled by balls with diameter of 9 mm. The induction in empty casket was 0.52 T. After its filling by the balls a polygradient magnetic field was formed with the induction from 1.0 to 1.4 T in the dependence on measuring point

location among the balls. The density of pulp was about 300 $g.l^{-1}$. Magnetic product was caught in the casket and non-magnetic one was washing out.

Dry magnetic separation was also realized in the casket. But in the difference of wet way the casket was lined by riffled plates. The induction of magnetic field was 1.3 T.

The results of wet separation of samples S-35 and S-50 are introduced in table 1 and 2. Parameters of the dry way of separation are described in table 3 and 4.

Table 1

S - 35

| | MASS YIELD | | CONTENT [%] | | RECOVERY [%] | |
|---|---|---|---|---|---|---|
| | [g] | [%] | $Fe_2O_3$ | $SiO_2$ | $Fe_2O_3$ | $SiO_2$ |
| M | 5.35 | 0.575 | 12.732 | 33.15 | 55.05 | 0.20 |
| N | 925.0 | 99.425 | 0.060 | 95.73 | 44.95 | 99.80 |
| | Σ 930.35 | Σ 100.00 | 0.133 | 95.40 | 100.0 | 100.0 |

Table 2

S - 50

| | MASS YIELD | | CONTENT [%] | | RECOVERY [%] | |
|---|---|---|---|---|---|---|
| | [g] | [%] | $Fe_2O_3$ | $SiO_2$ | $Fe_2O_3$ | $SiO_2$ |
| M | 9.45 | 0.65 | 13.046 | 28.51 | 59.30 | 0.19 |
| N | 1435.00 | 99.35 | 0.059 | 96.20 | 40.70 | 99.81 |
| | Σ 1444.45 | Σ 100.00 | 0.143 | 95.76 | 100.00 | 100.00 |

Table 3

S - 35

| | MASS YIELD | | CONTENT [%] | | RECOVERY [%] | |
|---|---|---|---|---|---|---|
| | [g] | [%] | $Fe_2O_3$ | $SiO_2$ | $Fe_2O_3$ | $SiO_2$ |
| M | 2.20 | 0.422 | 19.120 | 31.68 | 63.55 | 0.14 |
| N | 519.50 | 99.578 | 0.049 | 95.67 | 36.45 | 99.86 |
| | Σ 521.70 | Σ 100.00 | 0.133 | 95.40 | 100.00 | 100.00 |

Table 4

S - 50

| | MASS YIELD | | CONTENT [%] | | RECOVERY [%] | |
|---|---|---|---|---|---|---|
| | [g] | [%] | $Fe_2O_3$ | $SiO_2$ | $Fe_2O_3$ | $SiO_2$ |
| M | 2.05 | 0.294 | 22.820 | 21.15 | 67.10 | 0.06 |
| N | 694.80 | 99.706 | 0.047 | 95.98 | 32.90 | 99.94 |
| | Σ 696.85 | Σ 100.00 | 0.143 | 95.76 | 100.00 | 100.00 |

The obtained results can be summarized as follows:

- the sample S-50 was separated with higher efficiency in both ways of separation - lower $Fe_2O_3$-content and $Fe_2O_3$-recovery into non-magnetic product, as well as higher $SiO_2$-content and $SiO_2$-recovery into non-magnetic product, so the efficiency of separation increases together with the diameter of grain

- for deferrization of sands the dry way of magnetic separation is more suitable and by this it is possible to remove about 65 % of $Fe_2O_3$.

**4. Possibilities of efficiency rate enhancement of deferrization**

The possibilities of deferrization in detail were observed for sample S-35 with higher Fe-content - 0.146 % of $Fe_2O_3$ (during previous tests the Fe-content in S-35 was 0.133 % of $Fe_2O_3$). For this purpose the two-stage magnetic separation was applied. Obtained results were not satisfactory because of the Fe-content in non-magnetic products during application of the both ways of separation did not decrease under 0.045 % of $Fe_2O_3$.

Magnetic products after the first stage of separation under field of 1.0 T marked M1 as well as after the second stage under field of 1.3 T marked M2 were subjected to X-ray mineral analysis with the aim to observe the distribution of phases into the separation products.

In magnetic products M1 there were identified the garnets of almandine series as dominant minerals - pyrope $Mg_3Al_2(SiO_4)_3$ and almandine $Fe_3Al_2(SiO_4)_3$. The high intensity of peaks in X-ray reading of ortoclase $KAlSi_2O_8$ was also observed. The accompanying minerals are represented by hornblende $Ca_2(Mg,Fe)_5(Si,Al)_8O_{22}(OH)_2$, ilmenite $FeTiO_3$, staurolite $(Fe,Mg)_2Al_9Si_4O_{23}(OH)$, titanite $CaTiSiO_5$. Peaks of magnetite $Fe_3O_4$ and hematite Ð-$Fe_2O_3$ are covered by the ones of dominant minerals. But lastly mentioned Fe-minerals were identified by observation under binocular as accessories.

Quartz occurs as dominant phase in magnetic product M2. It is accompanying by ortoclase, oligoclase $0.7NaAlSi_3O_8$ - $0.3CaAl_2Si_2O_8$ and pyrope. By means of observation under binocular it was found out that the surface of quartz grains is soiled by limonite film.

On the basis of obtained knowledge dealing with the limonite film on the surface of quartz grains it can affirm that film prevents to enhancement of deferrization efficiency. For this reason it is needed to apply a technological operation for surface dressing with the aim to remove of surface layer of limonite. Such operation is currently realized by means of intensive agitation of pulp in a tank as the treatment by attrition in the practice.

The ultrasonic machine for multi-aimed cleaning TESLA UC 002 EM1 was utilized for the pretreatment of sands by attrition under laboratory condition. The operating frequency of this equipment is 25 kHz ± 20%. The samples of sands were subjected to acting of ultrasonics in the tank of cleaner during 30 and 45 minutes. Obtained products were decanted.

The content of $Fe_2O_3$ in sands decreased from 0.146 % to 0.139 % after 30 minutes of ultrasonics acting and to 0.114 % after 45 minutes, respectively.

Products of attrition attained the mass yield of 0.3 - 0.5 % at $Fe_2O_3$-content about 3.0 %. The recovery of $Fe_2O_3$ to attrition products was from 5.0 to 6.0 %.

The magnetic separation of sands pretreated during 45 minutes carried out according to the schemes represented in figures 3 and 4. The separating casket was lined by riffled plates.

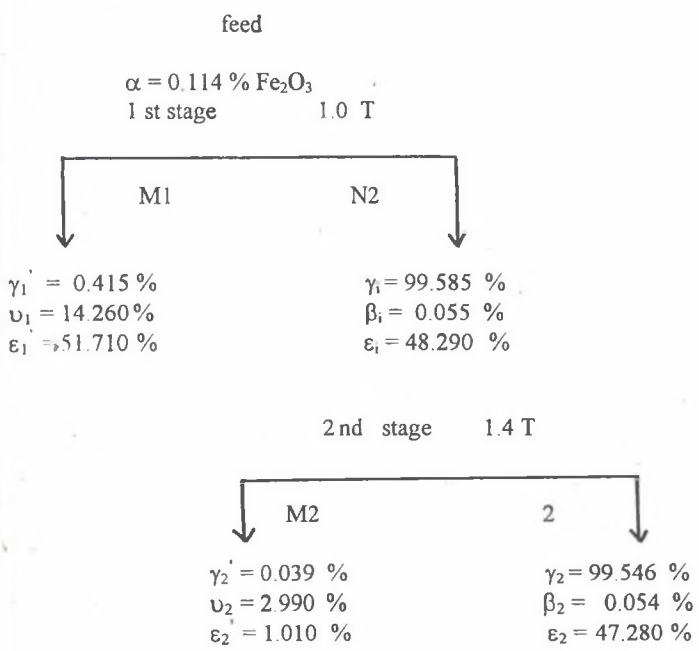


Fig. 3.
Rys.3.

| | |
|---|---|
| $\gamma', \gamma$ - mass yields of tailings and concentrate | [%] |
| $\upsilon$ - $Fe_2O_3$ content in tailings | [%] |
| $\beta$ - $Fe_2O_3$ - content in quartz concentrate | [%] |
| $\varepsilon$ - recovery of Fe | [%] |

The application of utrasonics in the pretreatment of sands results in the decreasing of $Fe_2O_3$-content in comparision with the one-stage and the two-stage magnetic separation without the pretreatment.

It was verified once again that dry way of separation is more efficient than wet one. The difference in $Fe_2O_3$-contents of non-magnetic products can be observed already after the first stage of separation (N1). Lower $Fe_2O_3$-content and $Fe_2O_3$-recovery were attained by application of the dry way of magnetic separation.

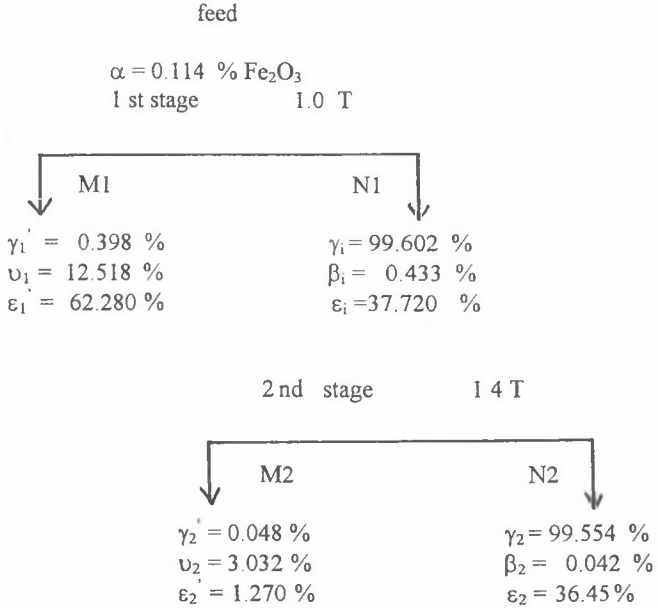


Fig. 4.
Rys.4.

## 5. Discussion and conclusion

The highest rate of deferrization of samples S-35 and S-50 was achieved by means of the dry way of magnetic separation under polygradient magnetic field formed by riffled plates.

Increasing of magnetic field over 1.0 T at application of the two-stage separation results in low efficiency of separation because of it is not possible to remove the iron bonded in limonite films on the surface of quartz grains by magnetic separation.

Conclusively, the obtained knowledge can summarize as follows [6]:

- so called heavy minerals can remove from sands with high efficiency under magnetic field of 1.0 T
- the content of $Fe_2O_3$ depends on the contamination-grade of quartz grains by limonite film.
- the content of $Fe_2O_3$ in final non-magnetic product can decrease by application of the surface dressing of quartz grains by attrition under ultrasonic field or intensive agitation
- dry way of magnetic separation is more effective.

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**Streszczenie**

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Zastosowanie tych piasków w przemyśle szklarskim jest ograniczone przez zawartość żelaza. Próbki piasku były przerabiane w suchej i mokrej separacji magnetycznej o wysokim natężeniu pola w poligradientowym separatorze Jones'a.

Wyniki pracy mają charakter użytkowy wskazując, że magnetyczna separacja na sucho jest bardziej efektywna. Również usuwanie filmu limonitowego z powierzchni ziarn kwarcu przez zastosowanie ultradźwięków poprawia efekt wzbogacania magnetycznego.