The wet high intensity magnetic separation of magnesite ore waste

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Abstract

The wet high intensity magnetic separation of magnesite ore waste stocked in an open pit of a magnesite mine was investigated in this paper. The received sample was subjected to physical, chemical, thermal and phase characterizations. The magnesite ore waste sample contained 77.69 % $MgCO_3$ and a considerable amount of Fe_2O_3 (3.14 %). The unwanted silica and iron impurities were removed and a high-grade magnesite was experimentally obtained. Results have shown that a high-grade magnesite was obtained after subjecting the non-magnetic portion of the processed sample twice at 1.8 T. It was possible to increase the magnesite content up to 91.03 % while reducing the iron content to 0.32 % by using magnetic separation. After the calcination process at 1000 ^oC, the sample showed mass loss on ignition of 52 % and contained 85.39 % MgO with 0.32 % Fe_2O_3. The final product can be used in chemical and metallurgical applications where high magnesia contents are required. The experimental results provide useful information on wet magnetic separation of magnesite wastes.

Keywords: Magnesite, mineral processing, beneficiation, calcination, magnesia, refractory

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1. INTRODUCTION

Magnesite is the major mineral of magnesium, while the other minerals are talc, brucite and dolomite [1]. Other mineral impurities in magnesite ore are quartz, apatite and small amounts of iron. Magnesite is formed by carbonation of magnesian serpentine in the presence of water and carbon dioxide under moderate temperatures and pressures. Chemical composition of magnesite ore is complex and varies from region to region. Depending on the source, it contains MgO (42-47 %), CaO (1.0-2.0 %), SiO_2 (1 %), Al_2O_3 (1 %), Fe_2O_3 (1 %) and 50 % mass loss on ignition. Depending on the magnesia content, magnesite ores can be classified into three groups as high (MgO > 46 %), middle and low (MgO < 43 %) grades [2].

Due to suitable physicochemical properties, magnesite is used in a wide range of industrial applications including ceramics, metallurgy, cement, fertilizers, animal feed and refractory materials. More than 90 % is used for production of sinter and caustic magnesia as fire resistance and slag materials in metallurgical applications in steel, chemical, and glass industries [3].

Magnesite ore occurs in ultrabasic and ultramafic peridotities as a cryptocrystalline type ore. Turkey is one of the largest magnesite ore producers and refractory materials exporters in the world (7 % of the total refractory materials production). The country has large magnesite ore deposits (approximately 2 % of the world total). Approximately, per year 2 million tons of magnesite ore is mined in the country that is used for obtaining magnesia compounds such as dead burned and fused magnesia. Mining of magnesite ore in the country is carried out by an open mining method in which the ore is beneficiated by hand/optical sorting, crushing, screening, scrubbing and magnetic separation [4]. High calcium and silica contents restrict purification of magnesite. Therefore, it is very important to reduce unwanted oxides in the ore. After the beneficiation processes, magnesite is subjected to calcination. Depending on the calcination temperature, magnesia is designated as reactive magnesia (700 – 1000 ^oC), dead/hard burned magnesia (1000 - 2200 ^oC) and fused magnesia (above 2750 ^oC).

Magnetic separation is based on direct physical separation of minerals in a magnetic field. Related to magnetic properties, minerals can be divided into three basic groups: ferromagnetic, paramagnetic and diamagnetic. Due to magnetic susceptibility differences in particles the separation is accomplished wet or dry, at various magnetic field intensities and in different basic device configurations. Selection of the magnetic separation method depends on many processing parameters including ore or mineral type, composition and grade, particle size as well as magnetic susceptibility of particles. In addition, production and marketing factors have to be also considered.

Magnetic separation has been used to upgrade and beneficiate variety of industrial minerals. The first application of the magnetic separation process on industrial minerals is to remove iron containing compounds and minerals such as hematite-limonite [5], taconite [6], pyrite (FeS_2), and pyrohiotite (Fe_7S_8) [7]. It is a dominant separation process for iron containing ores. The process principle, magnetic properties of materials [8,9] and applications are well explained in the literature [10]. Today, it is used in metallurgical, steel, and food industries, scrap processing, and medical, drug delivery and bio-applications [11].

A flowsheet for magnesite ore processing is shown in Figure 1 that is generally accomplished by crushing/screening, hand sorting and dry magnetic separation. In addition to these operations, froth flotation, leaching, agglomeration, coagulation or fluctuation methods can be also used. Selection of beneficiation methods depends on the mineralogical composition and texture of the ore. To increase the content or to recover the wanted compound, number of physical separation methods are applied such as froth flotation [12,13], electrostatic [14], gravity [15,16], or magnetic [17] separation processes. Each of the methods has advantages and disadvantages in applications, for example, the flotation process separates very fine particles but uses some chemical agents and water, which may create environmental pollution and problems. From this point of view, the electrostatic route is environmentally friendlier than the flotation method.
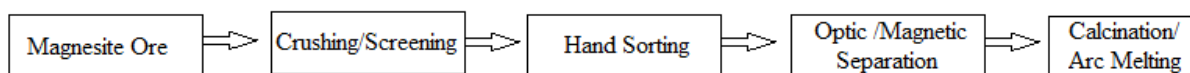

Figure 1. Flowsheet of magnesia processing

Extraction of magnesite from ore generates huge amounts of solid waste. Due to large amounts of magnesite tailings, it is important to utilize these wastes as a new potential magnesite source. Therefore, the main objective of the present study is characterization and beneficiation of a magnesite waste. Magnesite tailings from the Kütahya Magnesite Cooperation (KUMAS) Company were characterized and wet high intensity magnetic separation was applied to recover magnesite fraction below 3.00-0.10 mm in size. Characterization was performed by using thermal analysis, X-ray diffraction, scanning electron microscopy, elemental analysis and infrared spectroscopy.

2. EXPERIMENTAL

2. 1. Materials

Magnesite tailing was provided by the KUMAŞ Manyezit Sanayi AS (Turkey) that dominates in the magnesite mining industry [18]. The run of mine (ROM) magnesite ore is beneficiated by hand sorting and dry magnetic separation at the mine sites for pre-concentration. Then it is subjected to final beneficiation by high intensity dry magnetic separation. Depending on the impurity content in the ore, the company has seven magnesite products, such as supper (0.00 - 0.24 % Fe_2O_3), extra (0.25 - 0.29 % Fe_2O_3), special (0.30-0.33 % Fe_2O_3), quality 1-4 (0.34 - 0.72 % Fe_2O_3). Magnesite tailings from the plant contain significant amounts of magnesite as a low grade and are deposited in the plant in order to recover the valuable oxide, to reduce storage and environmental problems. At the same time, tons of magnesite ore waste material have been stocked every year causing the environmental pollution. The experimental procedure in the present work is presented as a flowsheet in Figure 2.
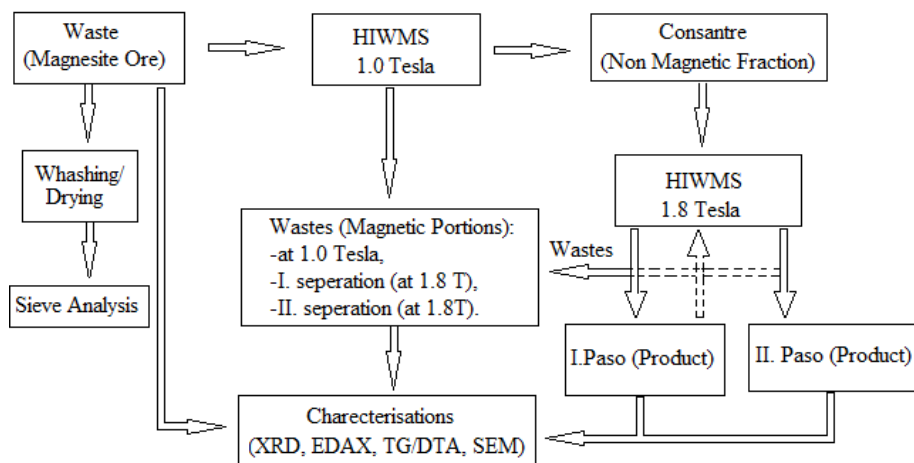
Figure 2. Flowsheet of the procedure used in this work for characterization and high intensity wet magnetic separation (HIWMS) of magnesite waste samples.

2. 2. Wet high intensity magnetic separator

A high gradient electro magnet was used for beneficiation of fine size -3.00+0.10 mm magnesite tailing. Magnetic separation experiments were carried out at the research laboratory of AKSA Magnet at Sakarya in Turkey. The separator consists of a separation canister packed with a strong ferromagnetic iron ball matrix. A magnetic field is trapped on the ball matrix, which collects magnetic particles while the non-magnetic portion is collected downstream. Intensity of the magnetic field developed between the coils was measured (Tesla units).

Approximately, a 50 kg sample was mixed with water (1:1 ratio) resulting in a slurry of a desired initial pulp density. The slurry was stirred and passed through the magnetic separator at 1 T, while the nonmagnetic slurry portion was collected downstream. The trapped magnetic portion was recovered from the ball matrix, after shutting down of the wet high intensity magnetic separator. The nonmagnetic portion was then subjected 2 times more to HIWMS at 1.8 T to yield final samples that were further analyzed (Fig. 2).

2.3. Analysis and characterization

Particle size range of the magnesite tailing received was 3.0 – 0.1 mm. Sample sieving was carried out to separate six different size fractions between 3.0 to 0.1 mm, by using a laboratory sieve vibrated for 5 min. Amount of material retained on each sieve was then weighed on a precision WLY PUE7 scale by Baykon.

For determination of mineral phases in the received samples and the products, X-ray diffraction method (D/max Rigaku, Japan) was used at the condition of Cu Kα radiation (λ=0.15418 nm) with a step size of 0.02º (2θ) and a scanning rate of 2º min^{-1}. Energy dispersive analytical X-ray (EDAX) was also used for basic chemical analysis of the received, processed and calcinated samples.

Thermal analysis of the mixture was performed on a simultaneous thermal analyzer (Netzsch STA 400, Germany). Thermogravimetric and differential thermal analyses (TG/DTA) were performed in an alumina crucible, under nitrogen atmosphere in the temperature range of 20-1450 ºC and the heating rate of 10 ºC/min.

X-ray fluorescence analysis of the received and processed magnesite samples was carried out on solid powdered spacemen using a PAN analytical Axios XRF spectrometer (Malvern, UK). This made the sample preparation process simpler and more accurate without the risk of contamination.

2. 4. Calcination and calcination behavior

Calcination is a pyrometallurgical process which depends on temperature, time, pressure, particle size and heating rate. In this process carbonates, hydroxides, sulfates, nitrates, and acetates are converted into oxide forms in a furnace at high temperatures in air.

A magnesite sample was calcinated in lab-scale electric muffle furnace at temperature 1000 ºC for 4h in air.

3. RESULTS AND DISCUSSIONS

3. 1. Characterization of the magnesite ore waste

Magnesium carbonate ($MgCO_3$) occurs naturally as the mineral magnesite in two physical forms, macro-crystalline (spathic) and cryptocrystalline (amorphous, compact) [4]. It was reported that, Turkey mostly has cryptocrystalline magnesite reserves. Cryptocrystalline magnesite is generally of a higher purity than macro-crystalline magnesite and generally contains lower amounts of iron oxide [3,4,7,18]. Magnesite deposits in the country are widely distributed and can be divided into two parts. The first part of the deposit is located from Kütahya to the Eskişehir region while the second part is in the east province of Erzincan [7]. The ore deposits often occur as an alteration product in ultrabasic rocks, typically serpentine (magnesium silicate). Magnesite ore used in this work comes from Kütahya region.

X-ray diffraction pattern of the received magnesite tailing sample is shown in Figure 3. Magnesite exists in the shape of granules and crystals in the ore. The main impurity minerals are dolomite, calcite, diabase, quartz and different forms of lizardite such as 1 M ($Mg_3(Si_2O_5)(OH)_4$), T (trigonal pyramids, $Mg_{2.82}Fe_{0.07}Al_{0.09})(Si_{1.94}Al_{0.06})O_5(OH)_4$), and 2H (hexagonal plates, $Mg_{2.83}Fe_{0.05}Al_{0.10})(Si_{1.93}Al_{0.07})O_5(OH)_4$). As expected, magnesite and lizardite were the second major phases in the sample. These impurities are important for successful mineral separation.
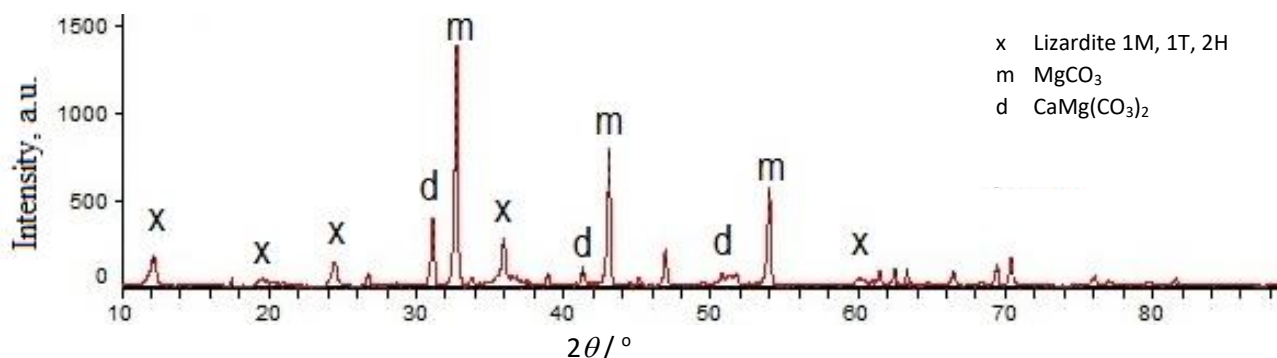

Figure 3. XRD pattern of the as received magnesite ore waste sample

It is known that, in magnesite refractories, magnesia and periclase are major phases. Composition of magnesite raw materials for production of magnesia has a critical effect on the quality of magnesite refractory materials. Higher magnesia and higher calcia to silica ratio result in higher refractoriness, while impurities such as iron and aluminum minerals have negative effects on magnesia refractory materials. Presence of these impurities leads to formation of metallic iron, which melts and creates holes that affect refractoriness, sintering, mechanical and thermal stability of magnesite refractory materials.

Relative proportions of particle sizes were determined by the sieve analysis test (Table 1). The particle size range of the sample was between 3.0 to 0.1 mm while the dominant particle size range was 2.0+1.0 mm that corresponds to 40.2 % of the total retained quantity. The particle size of the second large portion corresponds to 1.0+0.5 mm particle size range that is approximately a quarter of the total quantity.

Table 1. Sieve analysis of the magnesite tailing sample.

Particle size range, mm	3.0+2.0	2.0+1.0	1.0+0.5	1.0+0.25	0.5+0.1	<0.1
Weight fraction, wt. %	12.2	40.2	26.7	13.8	5.0	2.1

In order to evaluate magnesia content in the tailing the X-ray fluoresce (XRF) method was applied related to chemical analysis of the processed samples. The obtained data were in good agreement with previous studies that were a linear relationship was found. Chemical composition of the magnesite tailing (T) sample is shown in Table 2 at the first line. The main oxide was MgO in magnesite comprising 77.69 %, and the second oxide was silica comprising 12.10 % in various minerals that is serpentine, lizardite and quarts. The iron content in the received sample was 3.14 %. A number of trace impurities such as Al, Mn, K, Zn, Ni and Cr oxides comprised less than 0.5 % in total.

Table 2. XRF analysis of the received and processed samples

Samples	Content, wt. %											
	Mg*	SiO_2	Ca*	Fe_2O_3	Al_2O_3	NiO	Cr_2O_3	MnO	K_2O	ZnO	Mst.	Loi.
T	77.69	12.10	6.68	3.14	0.19	0.10	0.10	0.06	0.01	0.003	4.67	37.01
W	62.46	26.02	3.52	6.96	0.49	0.20	0.19	0.11	0.08	0.005	5.05	17.02
P	91.03	3.92	4.58	0.32	0.05	n.a.	0.07	0.01	n.a.	0.002	3.31	48.00

T: Magnesite tailing as received, W: Magnetic portion, P: Magnesite portion, Mst: Moisture content, Loi: Loss on ignition, *forms in a CO_3 structure

3. 2. Wet high intensity magnetic separation

Magnetic separation finds its application in mineral industry, where it is commonly used for removal of iron bearing minerals in ores. Today, wet high intensity magnetic separation (HIWMS) method offers potentials for higher product purity and reduced operating and maintenance costs relative to alternative hand sorting, dry, physical, or gravity separation processes. Introduction of magnetic separators to magnesite industry, to remove paramagnetic conta- minants highly improved product quality and doubled useful portion of ore. The process enables extraction of superfine (even colloidal) particles that are only weakly magnetic from a solid/water suspension.

Physical processing of the Turkish magnesite ore wastes from Kumaş by wet high intensity magnetic separation is aimed for removal of iron bearing minerals. Slurry of the received magnesite ore tailing was subjected to the magnetic separation process at 1 T to obtain two samples, the non-magnetic portion and the magnetic portion (W). The nonmagnetic portion was subjected to two more separation processes at 1.8 T for further purification yielding a sample termed P. W and P samples were analyzed by XRF and XRD methods. Results are shown in Table 2 in the second and third lines, respectively. It can be observed that the magnesite content reached up to 91.03 % after two consecutive applications of the wet magnetic separation process at 1.8 T to the magnesite tailing sample. The process was very effective for concentrating magnesite to obtain a high quality product. In Table 3, the first and the second lines show effects of the wet high intensity magnetic separation process on particle size distribution of the nonmagnetic portion of the sample.

Table 3. Effects of HIWMS on particle size distribution

Magnetic field intensity	Sample, wt.%	Particle size range, mm					
		3.0+2.0	2.0+1.0	1.0+0.50	1.0+0.25	0.5+0.10	0.10
0.1 T	P1	7.09	54.34	33.67	4.85	0.04	0.01
1.8 T	P	5.94	51.13	38.34	4.56	0.01	0.01
	W	9.98	58.09	27.25	4.58	0.09	0.01

W: Magnetic portion at 1.8T, P1: Magnesite portion at 0.1 T, P: Magnesite portion after two times separation at 1.8 T

The chemical composition results of the magnetic and the nonmagnetic portion of the process were compared with the as-received sample. From the chemical composition point of view, there are big differences in iron content of all samples.

In order to evaluate the wet magnetic processing, chemical composition, thermal behavior and X-ray diffraction pat- terns of the magnetic and non-magnetic fractions of the processed samples were analyzed and compared with the as- received sample. Recovery of magnesite and removal of iron bearing minerals from the tailing sample was successful and resulted in considerable differences in chemical compositions (Table 2). Iron content in the nonmagnetic fraction (P) is very low, and deceased from 3.14 to 0.38 %, but in the magnetic fraction it increased from 3.14 to 6.98 %. Unfortunately, the iron content in magnesite is not zero since it is in the spinel form in lizardite structures 1M ($Mg_3(Si_2O_5)(OH)_4$), 1T (trigonal pyramids, $Mg_{2.82}Fe_{0.07}Al_{0.09})(Si_{1.94}Al_{0.06})O_5(OH)_4$), and 2H (hexagonal plates, $Mg_{2.83}Fe_{0.05}Al_{0.10})(Si_{1.93}Al_{0.07})O_5(OH)_4$), which all consist of Al, Mg, Fe and Si. Lizardite is a kaolinite-serpentine group mineral and displays polytypes. Differences between lizardite phases come from octahedral and tetrahedral sheet structures. When Fe shows two valance states, the structure of lizardite sheets changes and becomes more complex. At higher magnetic intensity lizardite is separated from magnesite ore depending on the iron content. $MgCO_3$ content in the nonmagnetic processed sample was increased up to 91.03 % after the wet magnetic operation as compared to 62.46 % in the initial sample. Mass loss on ignition is related to carbonization of phases in the samples and the highest is in the magnesite portion (Table 2).

X-ray diffraction pattern of the nonmagnetic portion after one pass through HIWMS at 1.8T is shown if Figure 4. All identified peaks belong to Mg related oxides and minerals such as $MgCO_3$, MgO, $(Ca, Mg)CO_3$. The X-ray diffraction pattern of the magnetic portion as a waste of the process is presented in Figure 5. Different patterns and peaks can be observed. The magnetic portion contains different lizardite mineral forms as iron bearing minerals in the magnesite tailing sample. Chemical analysis of the samples supports the X-ray diffraction results on the base of the iron oxide content. As it is expected, the iron oxide content in the magnetic portion was the highest level among the three samples analyzed (T, P and W, Table 2). There were also color differences between the processed samples so that the magnetic portion was dark while the nonmagnetic portion was creamy-white.
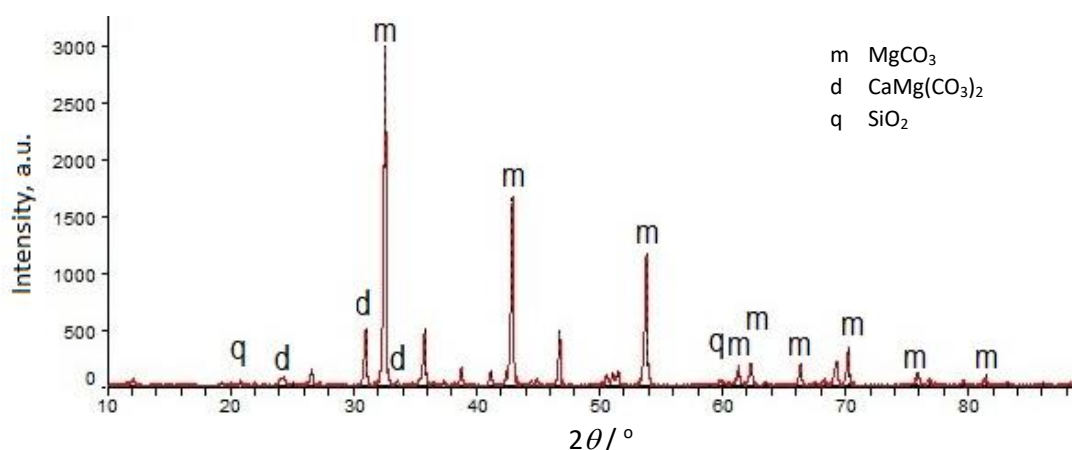

Figure 4. X-ray diffraction of the nonmagnetic portion after 1 pass through HIWMS at 1.8T
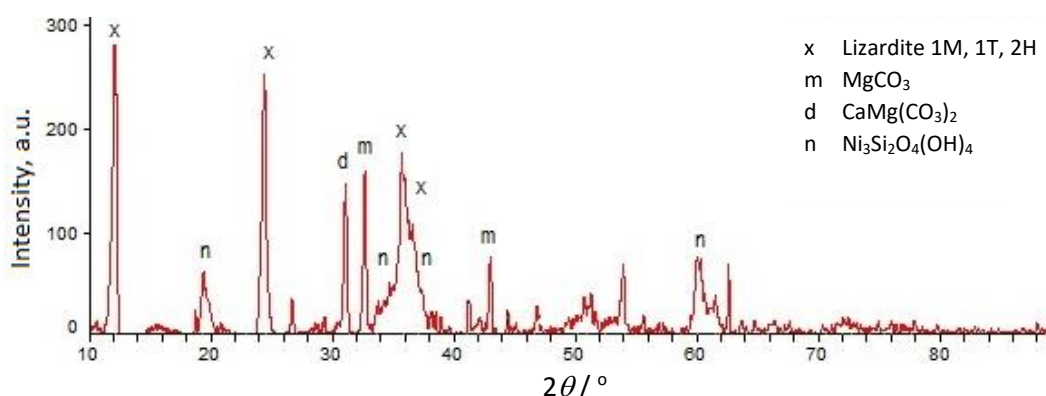

Figure 5. X-ray diffraction of the HIWMS waste (the magnetic portion after the HIWMS process)

An inverse relationship exists between MgO and iron bearing minerals contents in processed samples as expected. When the MgO content is high, the iron content is decreased. Variations of magnetic fractions in the processed samples confirm that the magnesite ore is a carbonate containing ore. Presence of iron oxide in the initial sample as well as in the magnetic portion is associated with traces of iron containing compounds of lizardite.

Iron content in a magnesite sample can be decreased or removed by a number of chemical, physical and physicochemical methods. However, magnetic separation is an eco-friendly method to remove ferrous oxides from magnesite tailings since it is a physical method without use of any chemical agents.

3. 3. Calcination and calcination behavior

Thermal treatment of magnesite is an important process in preparation of pure magnesia that is used for any metallurgical or chemical applications. Magnesite decomposition drives off CO_2 and produces magnesia. Depending on the thermal treatment temperature three products of magnesia can be obtained: calcinated, dead burned and fused. Conventionally calcination of magnesite is carried out at temperatures up to 1000 °C. The main objective of thermal

treatment of magnesite sample is removal of water and volatile organic components and dissociation of carbonate compounds.

Mass loss on ignition is an important criterion for minerals related to the thermal behavior that depends on the organic content. This parameter was calculated for the received sample and magnetic and the nonmagnetic portions of the processed samples (Table 4). As it is expected, the magnetic portion has shown the lowest loss on ignition that indicates the lowest carbonate content. On the other hand, the product sample (nonmagnetic) has a high loss on ignition value, which is related to the removal of carbonates in magnesite at high temperatures.

Thermal behavior of the magnesite ore tailing sample was investigated by using thermal analysis. TG/DTA curves of the sample are presented in Figure 6. The sample displays four various weight loss zones. The temperature range in the first zone was 25-436 °C at which 1.78 % weight loss was observed, followed by a large weight loss of 44.51 % occurring in the second zone in the temperature range 436-650 °C. The third zone was in the temperature range 650-826 °C in which 2.4% weight loss was observed. The final zone was 826-1200 °C with a slow continuing weight loss of 0.22 %.

As seen from the TG curve, the received sample starts to decompose at 436 ˚C and this process continues until 826 °C. Weight loss between these temperatures was 47 %. After this temperature and up to 1200 ˚C the weight loss was 0.22 %. Over the whole temperature range 25-1200 °C the total weight loss of the magnesite sample was then 48.91 %.
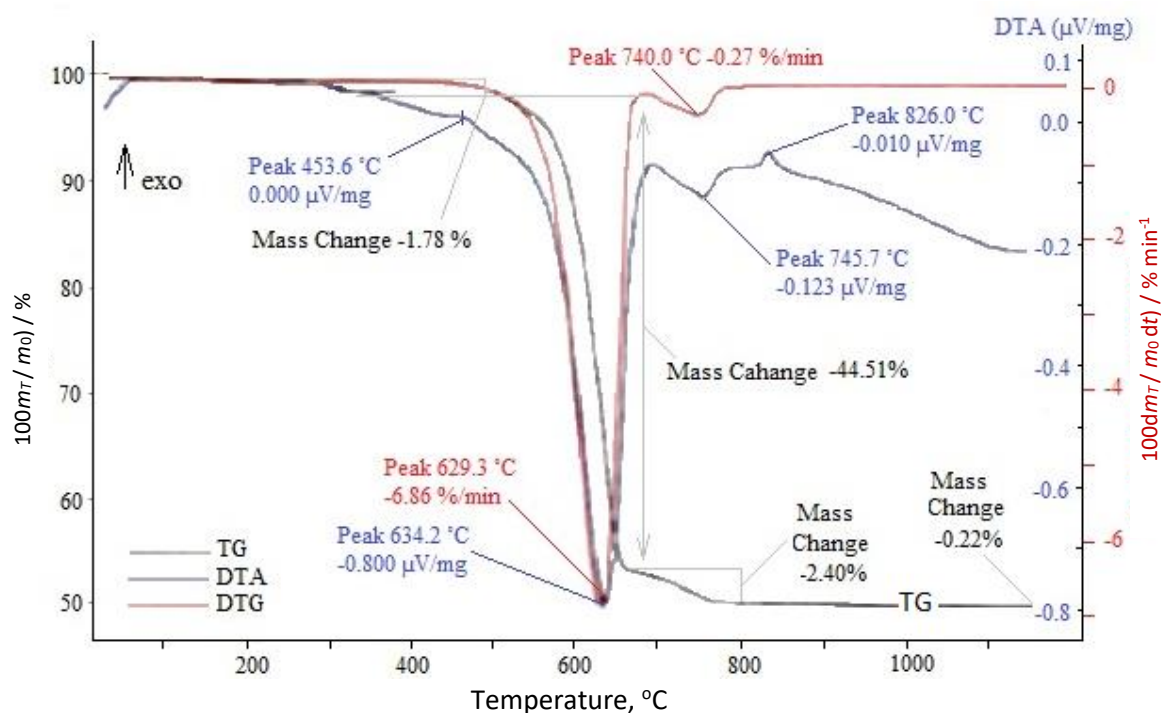
Figure 6 *Thermogravimetric and differential thermal analyses (TG/DTA) of the received magnesite ore tailing sample*

In the DTA curve of the received magnesite sample, three endothermic peaks can be noticed. The first small peak appears at approximately 454 °C probably due to dehydration of the sample. The second peak was sharp and major at 634.2 °C while the third endothermic peak was observed at the temperature of 745.7 °C.

It should be noted that there were two exothermic peaks at 650 and 826 °C. As carbonate is a major structure, with little gangue minerals, reactions will be dissociation of carbonates of magnesite and dolomite. The peak at 634 °C is attributed to decomposition of magnesite:

$$MgCO_3 = MgO + CO_2 \tag{1}$$

Pure $MgCO_3$ dissociates at this temperature to form 47.8 wt. % MgO and 52.2 wt. % CO_2. When heated sufficiently magnesia creates a crystal structure identical as in natural periclase. As explained above, various calcinated magnesia

can be produced with different densities and structures. The second peak at 634 ^{o}C corresponds to decomposition of dolomite:

$$CaMg(CO_3)_2 = MgO + CaO + 2CO_2 \tag{2}$$

Solid $CaMg(CO_3)_2$ undergoes thermal decomposition to produce solid magnesia and calcia powders and CO_2 according to reactions 1 and 2. $CaCO_3$ has to be calcinated at higher temperature than $MgCO_3$.

The endothermic peaks can be explained by dehydroxylation and dehydration reactions. The dehydroxylation of clinocrisotile ($Mg_3Si_2O_5\cdot(OH)_4$ phase breaks down into forsterite, (Mg_2SiO_4) and silica (SiO_2) at temperature between 634-745 ^{o}C with the following reactions:

$$2Mg_3Si_2O_5(OH)_4 = 3\ Mg_2SiO_4 + SiO_2 + 4\ H_2O \tag{3}$$

It was assumed that the dehydration temperature of lizardite is lower than the dehydroxylation temperature of clinocrisotile.

$$MgO\cdot4SiO_2\cdot H_2O = 3MgSiO_3 + SiO_2 + H_2O \tag{4}$$

After the wet high intensity magnetic separation process of the received magnesite sample, the non-magnetic fraction (product) was heat treated at 1000 $^{\circ}$C in air for 4h in an alumina crucible. XRD pattern of the calcinated magnesia is shown in Figure 7. The identified phase was only magnesia (MgO) and small amounts of trace phases such as quarts (SiO_2) and lime (CaO). As seen in Figure 7, other impurity phases were not found.
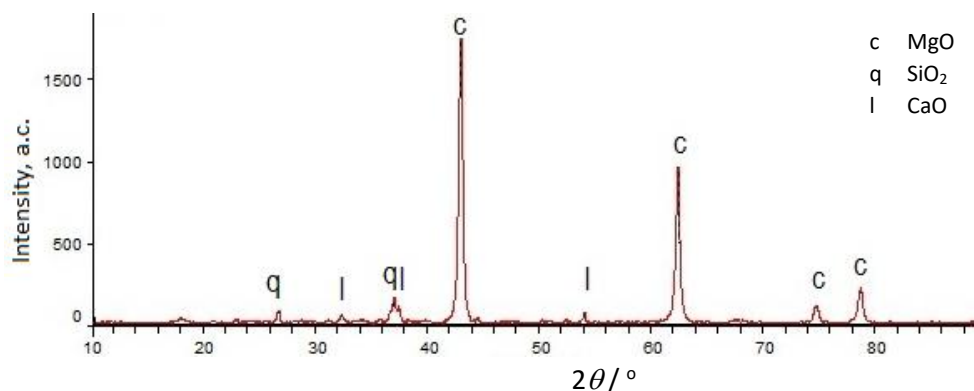

Figure 7. X-ray diffraction of the product (the nonmagnetic fraction) sample after calcination at 1000 $^{\circ}$C for 4h

Chemical analysis of the calcinated magnesia sample is presented in Table 4. The magnesia content has been increased significantly from 65.84 % in the initial ore tailing sample to 85.39 % with a decrease in the iron oxide content from 5.58 % to 0.63 %. The silica to CaO ratio is around 1.26 in the calcinated magnesia. This product is suitable for chemical and metallurgical applications [3,4,18].

Table 4. Chemical analysis of the calcinated magnesia

Oxides	MgO	SiO$_2$	CaO	Fe$_2$O$_3$	Al$_2$O$_3$	Cr$_2$O$_3$	MnO
Content Wt. %	85.39	7.72	6.14	0.63	0.09	0.63	0.02

4. CONCLUSIONS

This paper presents basic characteristics and a beneficiation method of Kumaş magnesite ore waste by wet high intensity magnetic separation (HIWMS) and calcination at laboratory scale. It is shown that the magnesite tailing consists of 77.69 % magnesite $MgCO_3$ with 3.14 % of Fe_2O_3. Characterization studies have shown that the iron bearing mineral, lizardite, was the main impurity in the sample. After the HIWMS process, $MgCO_3$ content was increased to 91.03 % while the Fe_2O_3 content was decreased to 0.38 % accompanied with a decrease in silica and alumina contents as well. The separation was successfully performed at the magnetic field of 1.8 T. There were differences in chemical compositions,

phases and even colors of the processed samples. The obtained magnesite was subjected then to calcination at 1000 $^{\circ}$C resulting in a product with 85.39 % MgO as was also confirmed by the XRD pattern.

Composition of the magnesite ore is stable providing possibilities for development of a process for removal of impurities. From this point of view, physical separation methods will have a critical importance for removal of iron bearing minerals. The wet high intensity magnetic separation (HIWMS) technique could be a solution for this problem. It can be used alone or in combination with other techniques, since the demand for high grade magnesia will increase as applications are broadening.

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SAŽETAK

Proces vlažne magnetne separacije visokog intenziteta otpada rude magnezit

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(Stručni rad)

U ovom radu je ispitan proces vlažne magnetne separacije visokog intenziteta rude magnezit iz otpada u kopu rudnika magnezita. Dobijeni uzorak je okarakterisan fizičkih, hemijskih fazno-termalnih karakterstika. Uzorak otpada iz rude magnezit sadrži 77,69 % $MgCO_3$ i znatnu količinu Fe_2O_3 (3,14 %). Uklonjene su neželjene nečistoće silicijuma i gvožđa i eksperimentalno je dobijen visokokvalitetni magnezit. Rezultati su pokazali da je visokokvalitetni magnezit dobijen nakon što je ne-magnetni deo obrađenog uzorka dvaput podvrgnut temperature od 1,8 T. Koriš-ćenjem magnetne separacije bilo je moguće povećati sadržaj magnezita do 91,03 % uz smanjenje sadržaja gvožđa na 0,32 %. Nakon procesa kalcinacije na 1000 °C, uzorak je pokazao gubitak mase pri paljenju od 52 % i sadržavao je 85,39 % MgO sa 0,32 % Fe_2O_3. Konačni proizvod se može koristiti u hemijske i metalurške svrhe, kada je potreban visok sadržaj magnezijum oksida. Rezultati ovog rada daju korisne podatke o vlažnoj magnetnoj separaciji otpada magnezita.

Ključne reči: magnezit, prerada minerala, obogaćivanje, kalcinacija, magnezijum oksid, vatrostalni