Geological Society of Malaysia, Bulletin 46
May 2003; pp. 223–230

The silica-based industry in Malaysia

AZIMAH ALI

Industry Relations Unit
Mineral Economics Division
Minerals and Geoscience Department Malaysia
19-22 Floor, Bangunan Tabung Haji
Jalan Tun Razak, 50658 Kuala Lumpur

Abstract: Malaysia has an estimated resource of 640 Mt of silica sand, of which 148 Mt are natural silica and 492 Mt tailing sand. These sources can be exploited and beneficiated for various industrial uses.

Silica sand is one of the important industrial minerals in Malaysia. In 2001, the production of silica sand amounted to 575,105 tonnes which was valued at RM 23.9 million. A total of 511,161 tonnes amounting to RM9.7 million was imported and 120,723 tonnes worth RM5.8 million were exported. It is an essential mineral commodity for the local industries, namely, the foundry, glass manufacturing, water filter, silicon wafer fabrication, and the chemical industry in the manufacture of sodium silicate.

During 2001, the production value of sand-based products totalled RM2.6 billion. The exports of glass and glassware amounted to RM1.2 billion while imports totalled RM1.4 billion. Apparent domestic consumption is estimated to be in the region of RM1.4 billion.

Although some of the high-end products, for example the optical glass and the lense sector is unable to consume domestic material due to the inability of our local silica processor to meet their requirement, others like the float glass manufacturer was consuming local material. As such, it is pertinent to ensure that the supply is sufficient to meet demand.

The silica-based industry, like all other industries are facing rising labour costs, expensive infrastructure, and escalating raw materials costs. However, a technology-based manufacturing methods could help offset the effect. With the incentives given by the government, foreign investment and global market ventures, supported by the massive amount of local raw materials and highly skilled domestic workforce available locally, Malaysia would be able to face the challenges ahead.

Abstrak: Terdapat sebanyak 640 juta tan sumber pasir silika di Malaysia, dimana 148 juta tan adalah pasir silika semulajadi dan 492 juta tan adalah dari hasil sampingan industri perlombongan. Sumber-sumber ini boleh di eksploit dan dibeneficiated untuk pelbagai kugunaan industri.

Pasir silika adalah salah satu dari mineral perindustrian penting di Malaysia. Dalam tahun 2001, sebanyak 575,105 tan pasir silika bernilai RM23.9 juta dikeluarkan. Sebanyak 511,161 tan bernilai RM9.7 juta telah diimport dan 120,723 tan dengan nilai RM5.8 juta telah dieksport. Ia merupakan komoditi mineral penting untuk industi tempatan, anatara lainnya untuk industri-industri foundri, pembuatan kaca, penapis air, fabrikasi wafer silikon, dan industri kimia dalam pengeluaran sodium silikat.

Dalam tahun 2001, nilai pengeluaran produk berasaskan pasir silika adalah berjumlah RM2.6 billion. Eksport kaca dan barangan kaca dianggarkan bernilai RM1.2 billion manakala import produk yang sama berjumlah RM1.4 billion. Penggunaan domestik adalah dianggarkan bernilai RM1.4 billion.

Walaupun beberapa produk hiliran bernilai tinggi, contohnya dalam sektor kaca optikal dan kanta, tidak menggunakan pasir silika tempatan disebabkan ketidakupayaan pengeluar pasir silika tempatan memenuhi keperluan, pengeluar-pengeluar lain seperti pengusaha kaca kepingan telah menggunakan bahan tempatan sepenuhnya. Oleh itu, adalah penting mempastikan bekalan bahan mentah adalah mencukupi untuk memenuhi permintaan pengeluar.

Industri berasaskan silika, seperti juga kebanyakan industri lainnya, sedang menghadapi masaalah dari segi kos tenaga buruh, infrastruktur, dan bahan mentah yang meningkat. Walau bagaimanapun, kaedah-kaedah pembuatan yang berasaskan teknologi diharapkan boleh mengurangkan kesan tersebut. Dengan insentif oleh Kerajaan, pelaburan luar-negara dan pasaran global, disokong oleh bekalan bahan mentah yang mencukupi serta tenaga buruh tempatan yang mahir, Malaysia seharusnya dapat menghadapi cabaran-cabaran akan datang.

INTRODUCTION

Silica sand is natural sand which contains high content of silica, generally higher than 98% silicon dioxide (SiO_2) (Harben, 1995). It is defined as one of the commonest minerals in the earth's crust. In nature, silica sand occurs as a crystalline mineral in many and varied forms. The most common is quartz, commonly clear or white, with a Mohs hardness of 7 and a specific gravity of 2.65 (Bruvel, 1999).

In Malaysia, silica sand is important as an exploitable industrial mineral. It is used mainly as construction

materials, foundry materials and in glass manufacture. It is also processed as a high-grade product commanding a higher value-adding premium price used in the chemical industries (Teoh and Kamal, 1993).

Presently, silica sand is used in glass manufacture and in the foundry and chemical industries. Table 1 shows the common uses of silica sand in Malaysia.

RESOURCES

The most common forms of silica sand in Malaysia is made up of two types:

(i) Natural sand deposits made up of beach sand and ridges, and

(ii) Man-made deposits of tailing dumps from alluvial mining areas.

Natural sand deposits fringe the peninsular almost continuously. Deposits of economical value however, are found as beach ridges mainly in Johor, Perak, Kelantan, Sabah and Sarawak. To date, more than 15 localities of natural silica sand, varying in geological age, reserves, grades, ways of assessment, and availability of infrastructure had been identified by the Minerals and Geoscience Department Malaysia (Jab. Mineral dan Geosains Malaysia, 1999).

The man-made deposits are found in tailing dumps resulting from the alluvial mining operations. They are located mostly in Perak, Negeri Sembilan, and Selangor. The current natural silica sand deposits (2000) stands at 148.6 Mt, of which 47 Mt is in Semenanjung, 44 Mt in Sabah and 57 Mt in Sarawak (Table 2). Tailing sand with potential for construction sand totalled 491.5 Mt (Chu, 1988).

Natural sand deposits fringe the peninsular almost continuously. However, natural deposits found as beach ridges of economic potential are found mainly in Johor, Perak, Kelantan, Sabah and Sarawak. The man-made deposits are found in tailing dumps resulting from the alluvial mining operations in Perak, Negeri Sembilan, and Selangor (Chu, 1988).

Malaysia currently has about 640 Mt of defined resources of silica sand, of which 148 Mt comes in natural form and 492 Mt found as tin tailing dumps. These deposits possessed further potential with upgrading. The natural silica sand possess silica, SiO_2 grade ranging from 89.5% and 99.9%. Of the total amount of tailing sand recovered thus far, 305 Mt were reported to have SiO_2 content of more than 95%. Table 3 gives the deposit location, reserves tonnage and grade of the silica sand deposits in Peninsular, Sabah and Sarawak.

PRODUCTION AND PROCESSING OF SILICA SAND

The processing and beneficiation steps used in producing upgraded and higher quality industrial silica sand may vary but the main processes include:

Table 1. Uses of silica sand (Azimah, 2002).

Silica-based Industry	Uses
Glass Industry	Silica sand (SiO_2), limestone ($CaCO_3$) and soda ash (Na_2CO_3) are fused at 1,100°C to make commercial glass. Composition is usually 75% silica, 10% lime, 15% soda ash. The sand should be of even grain size and have minimum silica content of 99.5%.
Foundry sand industry	Silica sand is used for moulds and cores in metal casting. It is relatively cheap, thermally and chemically stable, and with bentonite clay as binder, is reusable for multiple casting cycles. Specifications require well sorted, subrounded grains, with minimum silica content of 98%.
Chemical industry	Sodium silicate is manufactured from silica sand. This chemical is a starting point for detergents, fillers, and extenders in paints, rubber, and plastics for use in adhesives, sealants, toothpaste applications, and in making dessicant, silica gel.
Other uses	Natural abrasives; in the making of silicon carbide, ceramic and ceramic glazes, as fused silica in optical and laboratory instrument glassware, cement manufacture, water filtration, and as proppant to increase the permeability of oil and gas-bearing rock formations, construction industry, golf bunker sand, water filter.

Table 2. Natural silica sand deposits.

Deposits	Reserves Tonnage (Mt)
Semenanjung	47.5
Sabah	44.4
Sarawak	56.7
Total:	148.58

- Drying
- Screening
- Scrubbing
- Floatation
- Sizing
- Iron removal
- Grinding
- Acid leaching

During 2001, the production of silica sand amounted to 575,105 tonnes. This was valued at RM23.9 million and was produced from 11 silica sand producers. The quarries were located in Perak (4), Johor (4), Kedah (1), Selangor (1) and Sarawak (1). In terms of quantity percentage

Table 3a. Silica sand deposit location, reserves tonnage and grade (Jab. Mineral & Geosains Malaysia, 1999).

NATURAL SILICA SAND DEPOSITS				
Deposits	Locations	Grade		Reserves Tonnage (Mt)
		SiO_2%	Fe_2O_3%	
Semenanjung	Terengganu	97.38-99.88	0.001-0.11	45.64
	Johor	99.2-99.61	0.02-0.08	1.0
	Perak	99.01-99.76	0.002-0.091	0.57
	Kelantan	99.5-99.7	0.01-0.04	0.27
	Total			47.48
Sabah	Sipitang	99.0-99.6	0.01-0.06	5.4
	Balambangan	99.9	0.001	30.0
	Klias	89.5-99.5	0.01-0.68	9.0
	Paitan			
	Total			44.4
Sarawak (44 deposits)	Lundu-Sematan	98.1-99.6	0.01-0.32	4.3
	Bintulu-Miri	>99.0	0.001-0.19	6.5
	Similajau-Suai	>99.0	0.001-0.19	26.8
	Bakong-Marudi	98.0-99.9	0.006-0.096	8.3
	Lebaan, Sibu	>99.5	0.006-0.018	3.6
	Telagus	98.7-98.9	0.029-0.032	3.5
	Nyiar, Roban	99.2-99.7	0.01-0.06	3.6
	Sempadi	97.2-99.4	0.02-0.27	0.08
	Total			56.7
Grand Total:				**148.58**

Table 3b. Silica sand deposit location, reserves tonnage and grade (Jab. Mineral & Geosains Malaysia, 1999).

TAILING SAND WITH POTENTIAL FOR CONSTRUCTION SAND		
Deposits	Locations	Reserves Tonnage (Mt)
Pahang	Gambang	32.85
	Karak	1.04
	Bentong	7.13
	Mancis	1.06
	Sg. Kedaik	4.46
	Selendang	6.57
	Total	56.11
Terengganu	Sg. Pesur, Hulu Paka	4.1
	Sg.Tebak, Kemaman	2.2
	Kg. Cenih, Bandi	11.3
	Total	17.6
Johor	Jemaluang	5.31
	Kangkar Lenggor	1.58
	Sg. Tengkil	14.62
	Sg. Dohol	7.31
	Total	28.82
Selangor	Sg. Bernam	8.66
	Behrang	1.69
	Sg. Kerling	10.20
	Ampang Pecah	1.40
	Batang Kali	0.53
	Batang Berjuntai	84.04
	Rawang	6.80
	Kundang	0.91
	Puchong	10.41
	Dengkil	3.50
	Jenderam	22.90
	Total	151.04
Perak	Taiping	7.80
	Chemor	17.50
	Terung	7.84
	Batu Gajah	28.12
	Gopeng	15.24
	Jeram	29.40
	Mambang DiAwan	39.40
	Tg. Tualang	24.16
	Segari	0.98
	Sungkai	2.79
	Ulu Slim	5.13
	Behrang	12.62
	Besout	31.06
	Total	222.04
Negeri Sembilan	Sg. Gelami	0.98
	Sg. Lemis	1.94
	Sg. Triang	2.03
	Anak Sg. Lui	3.47
	Sg. Malau	7.50
	Total	15.92
Grand Total:		**491.53**

however, the majority of production came from Johor (36%) and Sarawak (35%). Perak, Kedah and Selangor contributed 21%, 7% and 1% each (Table 4) (Mohd. Suhaili *et al.*, 2001),

The extraction of natural silica sand were carried out in Johor and Sarawak whilst production in Perak were from the tin tailing areas. Table 5 gives the historical production quantity and value for 1997-2001.

PRICES, MARKET AND DEMAND

Prices

The price of silica sand in 2001 ranges from RM20-RM50 per tonne (Mohd. Suhaili *et al.*, 2001). Silica powder which is dependable on the mesh size (200-400) were priced at RM380-RM600 per tonne.

Market and Demand

In the industry market, silica sand prices per unit value of production, average RM30 for foundry silica sand, RM40 for glass manufacture silica sand, and RM1,000 for other categories of higher purity silica sand. For comparison

Table 3c. Silica sand deposit location, reserves tonnage and grade (Jab. Mineral & Geosains Malaysia, 1999).

TAILING SAND WITH SiO_2 > 95%		
Deposits	**Locations**	**Reserves Tonnage (Mt)**
Pahang	Gambang	29.12
	Karak	4.06
	Sg. Kedaik	4.45
	Felda Selendang	6.58
	Total	44.21
Terengganu	Sg. Pesur	3.29
	Kg. Cenih, Bandi	5.15
	Total	8.44
Johor	Jemaluang-Lenggor	6.89
	Sg. Lebak-Sg.Tengkil -Sg. Linggiu	14.62
	Sg. Dohol -Sg. Susur Rotan	7.31
	Total	28.82
Selangor	Sg. Bernam	8.66
	Behrang	1.69
	Sg. Kerling	10.2
	Batang Berjuntai	63.65
	Kundang	0.91
	Total	85.11
Perak	Taiping	6.06
	Chemor	2.66
	Terung	5.38
	Batu Gajah	27.55
	Jeram	26.07
	Mambang Di Awan	39.07
	Tg. Tualang	21.04
	Sungkai	2.03
	Behrang	8.52
	Total	138.38
Grand Total:		**304.96**

purposes, glass and tonnage prices in Europe range from USD6.10 to USD9.20 (Bruvel, 1999).

Based on statistics collected by the JMG's State office on an annual basis and data provided by the Department of Statistics Malaysia, almost 21% of the silica sand produced in 2001 was exported (Min. and Geoscience Dept., 2001). During the year, under the Standard International Tariff Code (SITC) 273-310-000, a total amount of 120,723 t of silica sand worth RM5.9 million was exported to countries such as Singapore (60%), Japan (18%), Phillipines (6%), Vietnam (2%) and others (14%) (Dept of Statistics Malaysia, 2001).

Table 4. Production quantity by state, 2001.

State	Production quantity (tonnes)	Production %
Johor	208,500	36
Sarawak	201,170	35
Perak	120,700	21
Kedah	37,440	7
Selangor	7,279	1

Table 5. Silica sand historical production quantity and value (1997-2001) (Mohd. Suhaili *et al.*, 2001).

Year	Quantity (t)	Value (RM), million
1997	949,948	18.4
1998	473,422	19.7
1999	508,723	19.7
2000	446,838	18.4
2001	575,105	23.9

Table 6. Trade statistics for silica sand (1998-2000) (Dept. of Statistics Malaysia, 2001).

SITC Code 273-310-000	1998	1999	2000	COUNTRY (2000)
Silica sand	Export 343,238 t RM7.7 mil	Export 276,089 t RM11.5 mil	Export 398,016 t RM15.0 mil	Singapore Japan Phillipines
	Import 28,284 t RM10.0 mil	Import 17,395 t RM10.2 mil	Import 7,538 t RM6.1 mil	Japan Thailand Australia

Meanwhile, a total amount of 511,161 t of silica sand were imported amounting to RM9.7 million. They were imported from Japan (27%), USA (14%), Thailand (13%), Australia (7%), and others (39%) (Dept of Statistics Malaysia, 2001). Although information on the consumer and grade of imported silica products was limited, these imports were believed to cater for the manufacturing of speciality glass products which include glass lenses, pharmaceutical glass products, and fibre glass products. These raw materials are not available locally and were therefore imported.

Some of these silica sand products were processed to semi-manufactured goods in Malaysia and re-exported to its parent companies for further processing. In the optical lenses industry for example, glass blanks were imported from Japan, ground and polished in Malaysia, and subsequently exported back to Japan to produce the final product.

Table 6 shows the trade statistics for silica sand for the years 1998 to 2000.

Table 7. Number of selected sand-based product manufacturers, by state (2001) (Azimah, Yusari and Mohd. Anuar, 2002).

Pdt	Kedah	Perlis	Penang	Perak	S'gor	WP	Neg. Semb.	Melaka	Johor	Pahang	T'ganu	K'tan	S'wak	Sabah	Total
Filter sand	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2
Glass	1	0	2	0	12	0	3	2	4	0	0	0	0	33	57
Silicon	2	0	0	0	4	0	0	0	0	0	0	0	0	0	6
Sodium silicate	0	1	0	0	0	0	0	0	2	0	0	0	1	0	4
Total	3	1	2	0	16	0	3	2	8	0	0	0	1	0	69

Table 8. Production value of sand-based products, RM '000 (1997-2001) (Dept of Statistics, 2002).

SITC Code 36910 Manufacture of glass and glass products	Sales value of own manufactured products (ex-factory) (RM'000)
1997	1,914,279
1998	2,045,838
1999	2,342,436
2000	2,800,965
2001	2,585,263

Table 9. Trade statistics of sand-based products (1998-2000) (Dept of Statistics Malaysia, 2001, Min. and Geoscience Dept, 2001).

SITC Code	1998	1999	2000	COUNTRY (2000)
664 Glass	Export RM655 mil	Export RM629 mil	Export RM689 mil	Indonesia Singapore India
	Import RM455 mil	Import RM606 mil	Import RM836 mil	Japan Singapore Germany
665 Glassware	Export RM235 mil	Export RM292 mil	Export RM473 mil	U.S.A Singapore Hong Kong
	Import RM431 mil	Import RM456 mil	Import RM521 mil	Singapore Japan Germany

THE SILICA-BASED INDUSTRY

Malaysia's domestic market for silica sand has traditionally been for industries related to the manufacturing of glass, the foundry industries and the chemical industries which include the production of sodium silicate, and the production of sand for use in the water filtration industry and the bunker sand for the golf course. The silicon wafer fabrication industry fully imported its semi-manufactured unpolished silicon (Azimah, Yusari and Mohd. Anuar, 2002).

In terms of industry, the silica-based industry can be divided into four categories, viz:

i. Glass industry (container, crystal, flat, funnel, tableware, insulating, laminated-tempered, optical, speciality glass)
ii. Foundry industry (mould)
iii. Chemical industry (sodium silicate, silicon wafer fabrication)
iv. Others (water filtered sand, bunker sand, cement, construction, etc.)

Table 7 shows the number of selected sand-based product manufacturers in Malaysia for the year 2001.

In 2001, there were 69 manufacturers involved in the manufacturing and value-adding of sand-based products. In line with the occurrences of the sand deposits in the country, most sand-based manufacturers were found in Sarawak (33), Selangor (16), and Johor (8). Perak and Kedah had 3 manufacturers each. Sarawak, Selangor and Johor accounted for more than 60% of the total number of sand-based manufacturers in the country.

The total output from these manufacturers was estimated at RM 2.6 billion, a slight decrease of 8% compared with RM2.8 billion registered for 2000. This translated to about 29% of the total industrial mineral-based products manufactured during the year. Table 8 gives the production value of sand-based products manufactured from 1997-2001 (Dept of Statistics, 2002).

Exports and imports of glass and glassware totalled RM1.2 billion and RM1.4 billion respectively in 2001. During 2000, taking into consideration the production value of glass and glassware of RM2.8 billion, the domestic apparent consumption thus is estimated at RM1.4 billion. Table 9 gives the total trade quantity and value for glass and glasswares for the years 1998-2000.

Table 10. Consumption of silica sand and projected growth in demand for sand-based industries.

Raw Material	Industry Sector	Sub-industry	Raw materials required	Source	% Usage growth
Silica Sand	Glass	Glass & Glassware	Silica sand Soda ash Cullet Limestone	Domestic Imported Domestic Domestic	5-10% n.a n.a n.a
	Foundry	Mould	Sand	Domestic	5-10%
	Chemical	• Sodium Silicate • Silicon Wafer • Fabrication	Silica sand Unpolished silicon wafer	Domestic & imported Imported	n.a n.a
	Others	• Water Filter • Gold Bunker Sand • Cement • Rubber • Construction • Metal Smelters	Silica sand Silica sand Silica sand Silica powder/flour Construction sand Sand	Domestic Domestic Domestic Domestic Domestic Domestic	n.a n.a >10% 5-10% 3-5% 3-5%

Table 11. Promoted Products under the Investment Promotions Act, 1986 (MIDA, 1995).

Industry	Promoted Products
Silica Sand -based Industry	• Laboratory, chemical or industrial ware • Decorative glasses and glassware • High tension electrical glass insulators • Glass envelopes (bulbs, tubes) for electrical lamps, electronic valves, etc. • Glass fittings for lighting purposes • Glass fibres in all forms produced from basic raw materials • Optical glass blanks • Frits, glazes and glass stains • Glass pellets • High grade silica sand and powder

CONSUMPTION OF DOMESTIC SILICA SAND

The consumption of domestic silica sand in the sand-based industry is confined to limited type of products. Table 10 gives an outline on the consumption pattern of the industry.

The sand-based industry, like all other non-metallic products is one of the several resource-based industry promoted under the 2nd Malaysia Industrial Master Plan, 1995-2005. Further development of this industry is important as its products is consumed in the domestic industry to support the higher value-added products, partly to replace imported raw materials (import substitution), and for the export market (Khairun *et al.*, 2001).

The industry had also shown growth, not only in Malaysia, but in the Asean region (Skillen, 1996). As a group, the sand-based products contributed 29% of the total non-metallics products in terms of value in 2000.

ISSUES, POTENTIAL AND OUTLOOK IN THE SILICA-BASED INDUSTRY

Issues

The sand-based industry is part of the non-metallics industry which is considered a resource-based industry. Its processed products is used to support many other industries which include the automobile industry and the construction industry.

Several factors associated with the health of the silica-based industry were:

- Linkages/dependency to the Construction Industry.
- Promotion of Investment Act, IMP.
- Technology, R&D and Value Adding (High Productivity, Advanced Technology, Quality Products, Search for New Products & Markets).
- Trade Development (AFTA, WTO and Trade Liberisation).
- Indigenous sand supply.

Linkages/dependency to the construction industry

Demand for industrial mineral-based products, such as the ceramics, glass and concrete products has always been closely linked to the growth of the construction sector. There are inter-dependence between the silica-based industry and the construction industry (Burrows, 2002). In Malaysia, the automobile industry is also closely related. It was evident as shown in the recent economic downturn that a negative economic situation imparted a very negative spill-off effect to the construction industry and the silica-based industry suffered accordingly. Hence, development projects such as infrastructure and the automobile industry is crucial on the silica-based sector.

Table 12. Multiplying factor for some silica-based products.

Raw Material	Price (RM/t)	Value-added semi-finished products	Price (RM/t)	Multiplying factor	Finished Products	Price (RM/t)	Multiplying factor
Silica Sand	20-50	Processed silica sand	90-150	2-8	Sodium silicate	500.00	10-25
		Processed silica sand	90-150	2-8	Container glass	1,600	10
		Pellets	3000	60-150	Crystal glass	140,000	50
		Float glass	990	20-50	Automobile/ safety glass	60-70/m^2	n.a.
		Float glass	990	20-50	Decorative/ architectural glass	2000	2-3
River Sand	8	Processed river sand (for construction)	15	2	Construction products		

In line with the construction sector's growth of 3-5% in the last few years and a projected 4% for next year, the impetus of the sand-based industry should gain in momentum.

Promotion of Investments Act, Mineral Enactment and the Industrial Master Plan

Under the Promotion of Investments Act 1986, and the Income Tax Act 1967, the silica-based industry as listed in Table 11 is considered as a promoted activity and the products manufactured are eligible for consideration for pioneer status and investment tax allowance (MIDA, 1995). There are several silica-based processes which is still unavailable locally, hence some intermediate products still need to be imported.

Technology, R&D and Value Adding

In line with the Government policies to emphasize downstream processing and industries, the technology development and 'value-adding' was conceptualised (Khairun, 2001). It was decreed to give encouragement and incentives to new companies developing technologies to refine and process materials.

According to MIDA, the term 'value adding' is defined as the 'gross sales less raw materials costs'. This factor should be emphasized throughout the industries. Sectors with high multiplying factor from raw materials to products should be encouraged. For example, Precipitated Calcium Carbonate (PCC), Ground Calcium Carbonate (GCC) and lime powder produced a higher value-adding factor to limestone. Hence, it should be given incentives to expand. It is also less dependant on other industry, for example the domestic construction industry, and has large potential in the global market. Table 12 show some multiplying factors for some silica-based products.

Effort in R&D should be geared into understanding the industry need and focusing on complimenting their need. Higher quality products manufactured should cater for both the domestic and global market.

Some suggestion to upgrade the industry include the following:

- increased productivity by using advanced technology
- producing superior products to match and compete with global markets
- research into new products
- creating new markets

Trade development

The silica and silica-based product market, especially the glass industry in Malaysia can be considered a matured market. It is very unlike that there will be much increase in the production in the near future (MIDA, 1995). The present capacity is capable of maintaining domestic demand, thus a substantial amount of products is exported. Although the container glass market is facing a glut and opportunities in the flat glass sector is reportedly rather limited, there is potential in the speciality glass sector throughout the region.

For example, the major funnel and panel glass producers in the country is very optimistic of the future market. They are taking advantage of the lucrative export market while 'welcoming' globalisation with expansion plans in productivity.

With AFTA coming into force, the silica-based sector should prepare itself to sustain and compete in the open market.

Indigenous sand supply

Local silica sand should be use in the most optimum manner. Mineral resources, left unexplored and unprocessed, is of no value to the economy. Malaysia is endowed with abundant silica sand resources which, after processing would be able to produce high quality silica sand to cater for the silica sand -based industry.

Although some of the high-end products for example the optical glass and the lenses sector is unable to consume domestic material, other manufacturers were consuming local material. As such, it is pertinent to ensure that the supply is sufficient to meet demand. The quality of sources,

the consistency of supply and the continuous exploitation and extraction all play a role in ensuring that the supply and demand factor is maintain and the industry is allowed to developed fully.

POTENTIAL AND OUTLOOK

There is no doubt that Malaysia has a vast potential of sand deposits, which if fully utilized, could help to reduce the country's current import dependence. Presently, in spite of having a resource base of over 600 Mt of sand, Malaysia still need to import 7,000 t of silica sand annually.

It was reported that Malaysia, like many other developing countries, has become a victim of its own success (Skillen, 1996). The silica-based industry, like all other industries are facing rising labour costs, expensive infrastructure, and escalating raw materials costs. However, a technology-based manufacturing methods could help offset the effect. With the incentives given by the government, foreign investment and global market ventures, supported by the massive amount of raw materials and highly skilled domestic workforce available locally, Malaysia would be able to face the challenges ahead (Chu and Azimah, 2001).

REFERENCES

AZIMAH ALI, 2002. *'Opportunities in the Silica-based Industries in Malaysia'*, paper presented at the Mineral Exploration Conference 2002, Minerals and Geoscience Dept Malaysia

AZIMAH ALI, YUSARI BASIRAN AND MOHD. ANUAR M. YUSOF (compilers), *Directory of Industrial Mineral-based Industries 2001/2002,* Minerals and Geoscience Dept, Malaysia

BRUVEL, F., 1999, Silica Sand. *Mineral Information Leaflet No. 3,* Dept. of Mines and Energy, Queensland.

BURROWS, S., 2002. European Flat Glass, A Mineral Suppliers Viewpoint,, *Industrial Minerals, May 2002.*

CHU, L.H. AND AZIMAH ALI, 2001. *The Industrial Mineral-based Industries in Malaysia – Current Status and prospect, 2001* paper presented at the Geological Society of Malaysia Annual Conference 2001.

CHU, L.H., 1988. *Silica Sand Resources of Malaysia,* Geological Survey Department Malaysia Report.

DEPARTMENT OF STATISTICS MALAYSIA, 2002. *Monthly Manufacturing Statistics.*

DEPARTMENT OF STATISTICS MALAYSIA, 2001. *Tables and Summaries* 2001.

HARBEN, P.W., 1995. Silica and Quartz in *The Industrial Minerals Handybook,* Industrial Mineral Division, Metal Bulletin PLC, London, UK.

JABATAN MINERAL DAN GEOSAINS MALAYSIA, 1999. *Laporan Ringkasan Kajian Pasir Bekas Lombong Semenanjung Malaysia, Projek Mineral Perindustrian, RMK7, IM1/99.* Jabatan Mineral dan Geosains Malaysia.

KHAIRUN AZIZI MOHD. AZIZLI *ET AL.*, 2001. Opportunities in Mineral Processing, Value Adding and Import Substitution. Presented at the National Mineral Seminar, Sabah.

MALAYSIAN INDUSTRIAL DEVELOPMENT AUTHORITY (MIDA), 1995. *List of Promoted Activities and Products for High Technology Companies.* Gazette Notification No. P.U.(A)32, 1995.

MINERALS AND GEOSCIENCE DEPT. MALAYSIA, 2001. *Mintrade 1998-2001.*

MOHD. SUHAILI ISMAIL *ET AL.*, (compilers), 2001. *Industrial Mineral Production Statistics and Directory of Producers in Malaysia, 2001.* Department of Minerals and Geoscience Malaysia.

SKILLEN, A., 1996. 'Indonesia, where everything can be arranged', *Industrial Mineral Journal, 1996.*

TEOH, L.H. AND KAMAL DARIL, 1993. *Mineral Commodity Report: Silica Sand.* Geological Survey Report, CRU 3/1993. Geological Survey Dept Malaysia.

Manuscript received 10 April 2003