ALTERNATIVE RAW MATERIALS (ARM)

AND

COMPOSITE CEMENTS STRATEGIES IN ARCHIPELAGO COUNTRIES

KEYS TO COMPETITIVENESS

Dr. Hans Wilhelm Meyer & Piet Hein Heersche
CEMCON AG

ALTERNATIVE RAW MATERIALS (ARM)

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ALTERNATIVE RAW MATERIAL (ARM)

Ratio of raw material to fuel (coal) consumption in modern clinker production is in the range of 7.5 to 1.

Targets of ARM utilization:

- ✓ Reduction of production cost.
- ✓ Potential increase of clinker production capacity due to mineralizing effects.
- ✓ **Gain of disposal fees.**
- ✓ Reduction of use of primary raw materials (saving of existing deposits/concessions).
- ✓ **Improvement of process operation (reduction of sintering zone temperature, NOx emissions, mineralization effects, etc.).**
- ✓ Maintain or improve of product quality, e.g. setting time or compressive strength.

Current situation and examples:

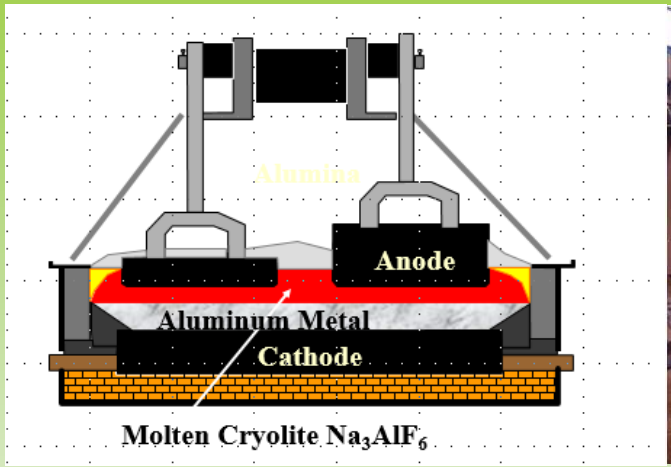
- ✓ Cement plants in Europe use approximately 8 % ARM in average, e.g. Cement Plant Lengfurth/Germany with 1 Mio tpy clinker production line.
- ✓ Cement Plant in Austria substitutes 36 % of raw materials by ARM at 0.3 Mio/y kiln line.
- ✓ Today ARM are efficiently used in innovative companies and special cement production (e.g. white cement).

THERE IS A HUGE POTENTIAL OF ARM FOR UTILIZATION IN THE CEMENT INDUSTRY!!!

ARM EXAMPLES & SOURCES

ARM (Examples)	Source	Properties	Disposal fees
Dry lime sludges	Alumina industry	Raw material (Ca), +/- calorific value, +/- mineralizing effects	+
Spend sand blasting material	Various industries	Raw material, +/- low calorific content	+
Filter dust materials	Pharmaceutical, chemical and other industries	Raw material (Ca, Si), +/- calorific value	++
Spend pot lining ash (untreated, 1st cut); SPL	Alumina industry	Raw material (Ca, Si, F), +/- calorific value, +/- mineralizing effects	++
Spend pot lining ash (treated), Treated SPL	Alumina and processing industry	Raw material (Ca, Si, F), +/- calorific value, +/- mineralizing effects	-
Foundry sand	Metal industry	Raw material (Si, Fe)	+
Sewage sludge	Municipalities/Waste water treatment plants	Raw material (Ca, Si, Fe), +/- low calorific value	+ (?)

EXAMPLE SPL (Origin & Composition)



Sketch of Alumina Smelter (Source: ALCOA)

Series of Alumina Smelters

Pot Lining

Raw SPL
Untreated
1st Cut

Constituent	1st cut only	1st and 2nd cut
Carbon	55 ± 5%	30 ± 5%
Fluoride	13 ± 3%	15 ± 3%
Sodium	12 ± 5%	15 ± 3%
Aluminum	10 ± 2%	15 ± 5%
Cyanide (total)	50 -10,000 ppm (0.2% average)	
Silicon	3%	4%
Calcium	3%	4%
Sulfur	0.2 ± 0.1%	0.2 ± 0.1%
Kcal/kg	4.440	2.500

SPL typical composition

EXAMPLE SPL (Advantages/Disadvantages)

Advantages of raw SPL utilization:

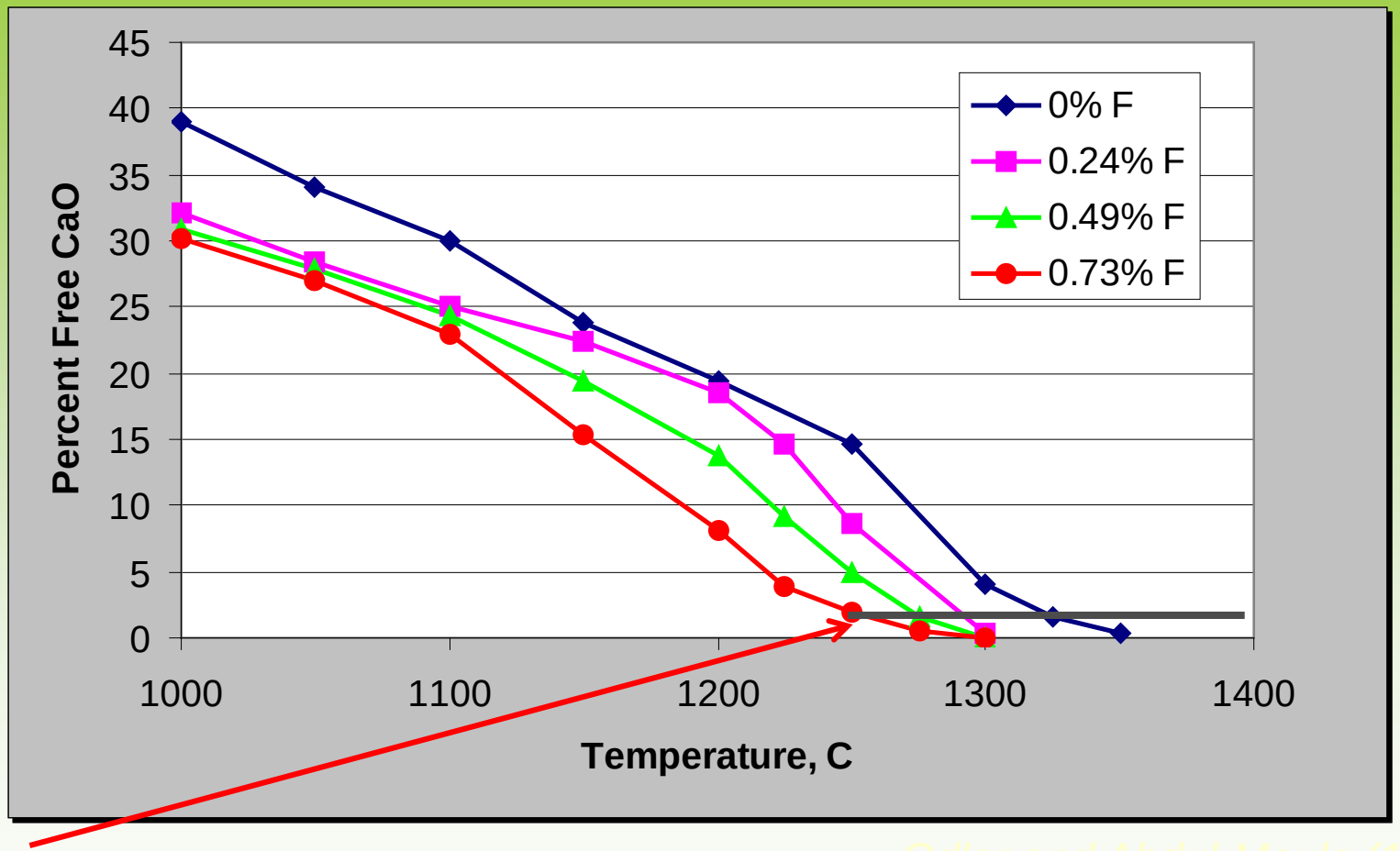
- ✓Increase C_3S through mineralization.
- ✓Reduction of sintering zone temperature at target free lime.
- ✓Reduction of limestone consumption.
- ✓**Typically gain of a disposal fee for raw SPL.**
- ✓**Gain additional NCV through remaining Carbon from Anode-electrode.**
- ✓Can be interground, e.g. with petcoke. Similar grindability.

Disadvantages of raw SPL utilization:

- ✓Due to its Cyanide content SPL is considered hazardous waste.
- ✓Challenging material concerning import, transport, handling, storage and preparation due to its hazardous character (investment cost regarding safety and environment).
- ✓Material might be heterogeneous and contaminated with remaining melted Alumina pieces to be extracted.
- ✓Need to be crushed.
- ✓Has to be introduced at the “hot end” only, typically via the main burner to crack Cyanides.

Disadvantages of can be mostly eliminated/mitigated by utilization of treated SPL (washing out of Cyanides). But cost will apply for treated SPL.

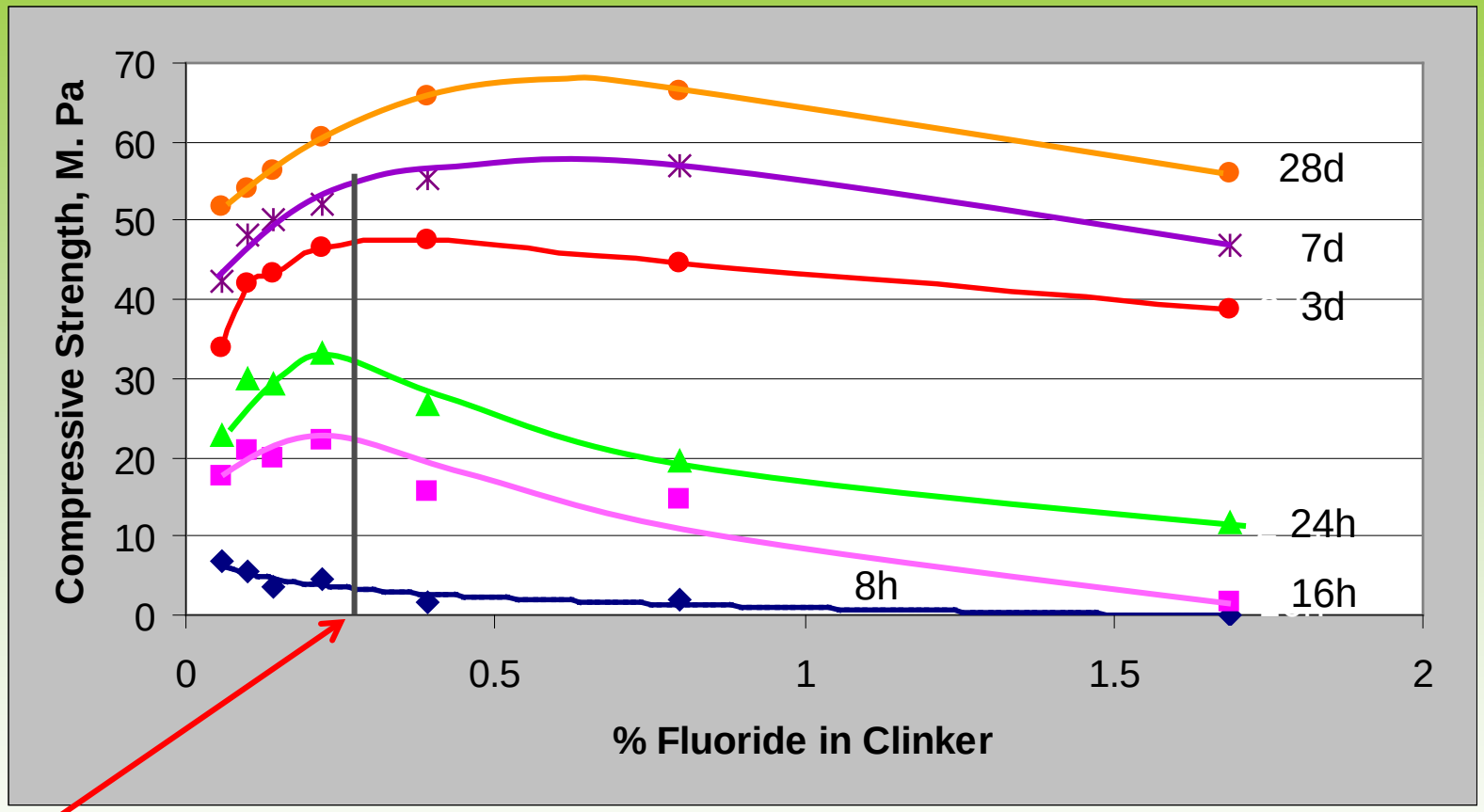
EXAMPLE SPL (Influence on Operation and Product)



Odler and Abdul-Maula (1980)

At 1.5 % free lime in clinker sintering zone temperature could be reduced by up to 80 °C resulting in related energy savings, longer life time of brick lining and reduction of NOx emissions.

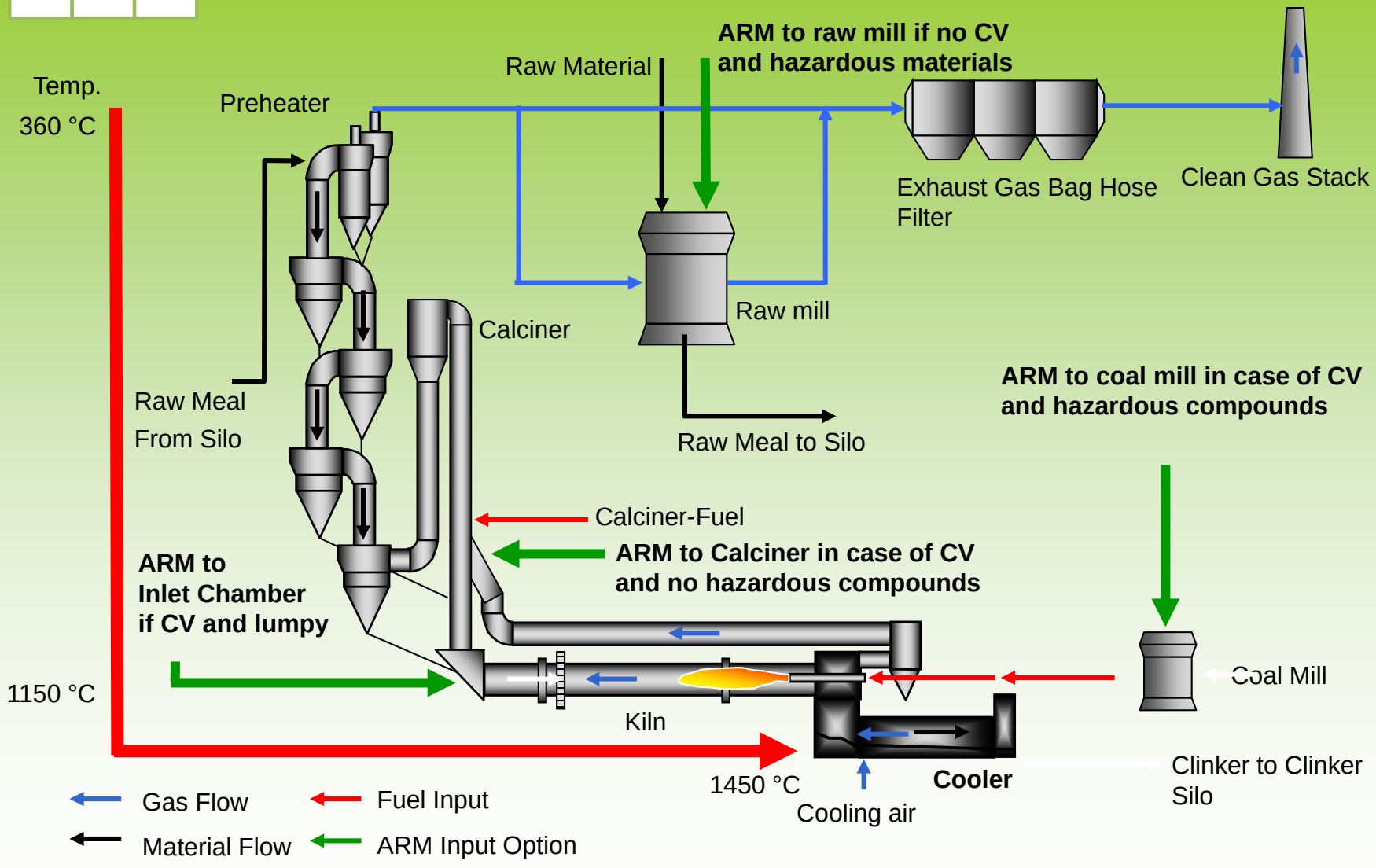
EXAMPLE SPL (Influence on Operation and Product)



Moir (1982)

Significant increase of compressive strength at 0.3 % Fluoride concentration in clinker by SPL (approximately 8-10 MPa).

UTILIZATION OF ARM IN CLINKER MANUFACTURING PROCESS



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ARM CONCLUSIONS

Recent examples of ARM utilization in the European, the Indian and the UAE cement industry indicate that saving potential by ARM is within Mio of USD.

✓ARM can be beneficially used to substitute raw materials and gain disposal fees.

✓ Benefits for product quality of clinker and cement are possible.

✓ The range of ARM is wide.

✓ Feasibility and benefits are dependent on a variety of factors and are strongly dependent on individual case of a cement plant:

- Availability of ARM materials in sufficient quantity and quality.
- Process and raw material composition of a particular plant.
- Laws and country of application.
- Disposal fees or sales prices.
- Transport and logistic costs.
- Investment cost into storage, handling, dosing, etc.

As outlined ARM utilization can contribute to improvement of profitability and competitiveness of a cement plants.

COMPOSITE CEMENT STRATEGIES IN ARCHIPELAGO COUNTRIES

COMPOSITE CEMENT - ADDITIVES - STANDARDS

Natural additives	Hydraulic properties	Typical range of admixtue in PCC
Limestone	None/ Filler only	5-8 %
Trass	+	5-15 %
Pozzolana	++	5-20 %
Industrial additives		
Granulated blast furnace slag (GBFS)	+++	up to 65 %
Fly ash	++	2-10 %

EN 197 and ASTM standards are determining a series of PCC cement types, e.g. Blast Furnace Slag Cement, Pozzolanic Cement, etc.:

Type I: OPC

Type II: Portland Composite

Type III: Blast FS Cement

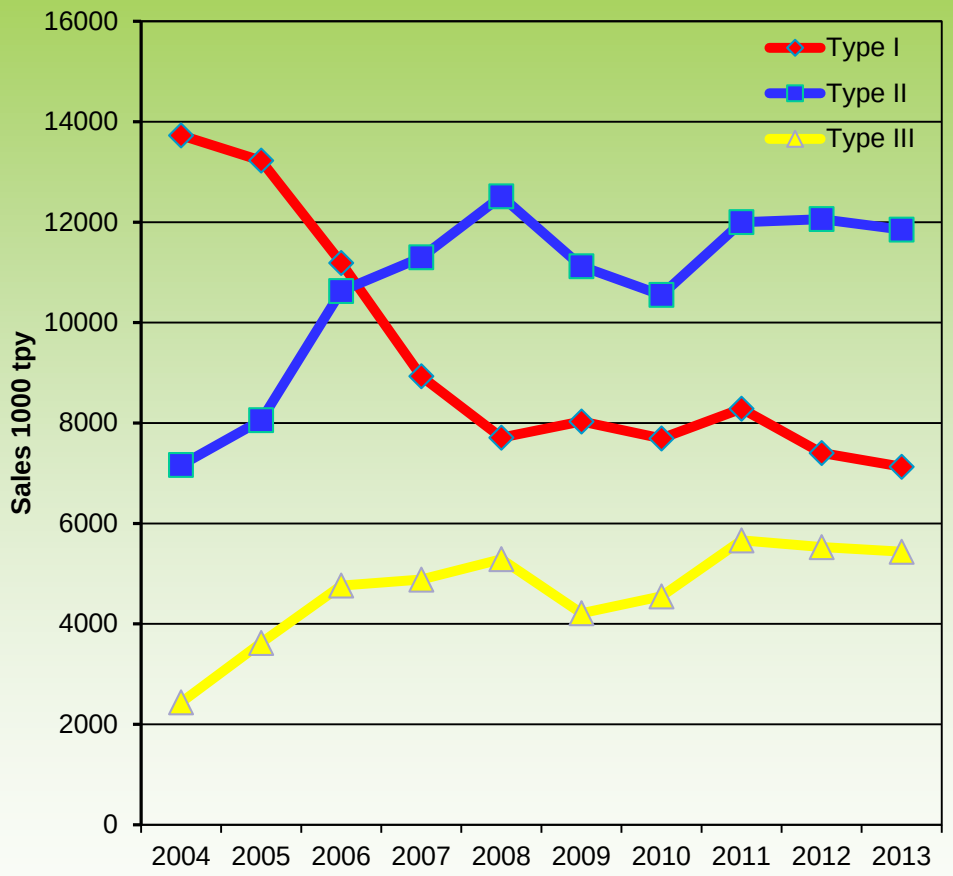
Type IV: Pozzol. Cement

Type V: Composite Cement

In national standards in Asia e.g. in Indonesia this flexibility of cement types is often not reflected. E.g. there is no Blast Furnace Slag Cement under Indonesian SNI standards existing but only PCC with maximum 35 % additives. As a consequence products with more than 35 % additives have to be classified as none standard cements. There are approximately 1.2 Mio tpy of GBFS available and more could be imported.

Philippine standards follow mainly ASTM. Hence suitable standards are available. But there is insufficient GBFS available.

ACTUAL SITUATION AND TARGETS



Source: VDZ Environmental Data 2013. German Cement Industry.

As an example the volume of composite cement vs OPC in Europe (e.g. the German cement industry) is in the range of 2.5 to 1.

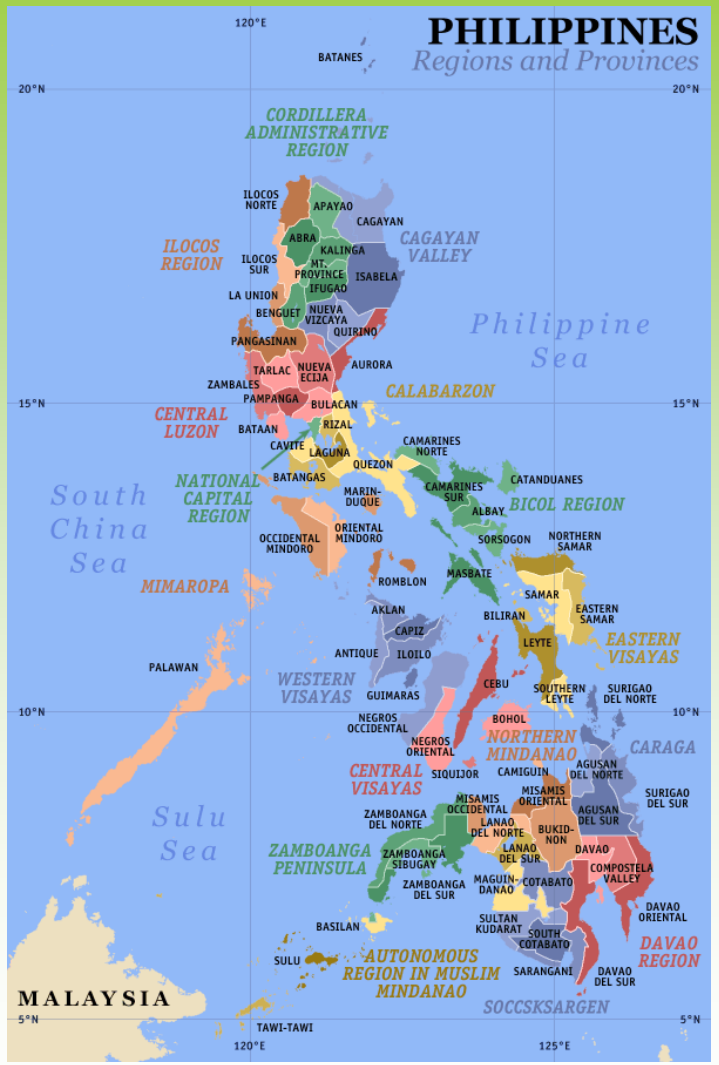
The average cement to clinker factor as indicative parameter over the complete German national production is 1.36 with rising tendency. In many cases about 50 % of the clinker is substituted.

In Indonesia and also in the Philippines there is another situation:

The proportion of composite cement vs OPC production is similar at a rate of 2 to 1. However there is remarkable lower additive proportion in the PCC. Usually in the range of 25-30% only.

It is desirable to increase this factor and reduce expensive clinker content in the cement due to economic and environmental reasons.

PHILIPPINE AND INDONESIAN ARCHIPELAGO



- Philippine archipelago consists of 7107 islands.
- Indonesian archipelago consists of 17508 islands.
- One of the most economically growing countries.
- Philippines: 86 Mio people with appr. 225 kg/capita.
- Indonesia: 220 Mio people with appr. 230 kg/capita.
- Economical growth 5 – 7 % pa.
- **Both countries can provide substantial amounts of pozzolana or trass due to its volcanic nature.**
- **Due to archipelago geography markets are divided into main mass markets and inter island markets.**

OBSTACLES AND SOLUTIONS OF PCC PRODUCTION AT MAIN MASS MARKETS

General:

- Installed grinding technology (e.g. ball mills or roller press ball mill circuits) is mainly based on intergrinding of clinker and additives thus limiting the cement/clinker factor. Only 20-30 % of additives can be interground dependent on availability of quantity and quality of additives.
- National standards, e.g. in the Indonesia do not include high additive cements, e.g. blast furnace slag cement but only PCCs with maximum 35 % additives.
- Possibilities of additive admixtures like GBFS around urban areas not fully utilized. E.g. 1.2 Mio tpy of GBFS available around Jakarta market. Fly ash market not fully utilized.

Solution:

Installation of modern and high efficiency grinding technology, e.g. VRM or roller press for separate and specific grinding of GBFS and other additives and production of mixed cements.

If necessary production of none standard products depending on national standards.

EXAMPLE: HIGH EFFICIENT GRINDING STATION NEXT TO STEEL PLANTS (GBFS SOURCE) NEAR JAKARTA

Installation of high energy efficient and flexible grinding plan utilizing GBFS:

- 150 tph cement grinding at 3600 Blaine.
- 95 tph of GBFS grinding at 4400 Blaine.
- Installation of a battery of silos for cement, GBFS and mix cements.
- Utilization of limestone, trass, fly ash and GBFS as additives.
- Production of various cements and none standard products, e.g. OPC, PCC (up to 35 % additives, “Slag cement product” (up to 50 % additives).
- Drastic cost reduction by low grinding energy consumption (32-34 kWh/t) and high additive admixture (up to 50 %).
- **Hence supply of mass market with significantly improved competitiveness and profitability was achieved.**

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OBSTACLES AND SOLUTIONFOR INTER ISLAND MARKET PROFITABILITY AND GROWTH

General:

- Cement production is concentrated to serve urban areas, e.g. NCR Manila, Jakarta – Bandung, Surabaya.
- Inter island market are supplied mainly by shipment from larger production facilities.
- Inter Island market characterized by:
  - Often over proportional growth.
  - Small market volume (not sufficient to install clinker production).
  - Mainly bag cement almost no bulk cement market.
  - Poor infrastructure (ports and roads resulting in multi handling of bag cement).
  - Limited availability of industrial additives (e.g. GBFS, fly ash).
  - High transportation cost (multiple handling of cement).
  - Availability of natural additives (limestone, trass, pozzolana).

Solution:

Shipment of clinker from cement plants and production of Composite Cements with mobile, flexible and small grinding units installed at islands with attractive quantities of additives available.

EXAMPLE: MOBILE, SMALL INTER ISLAND GRINDING UNIT

Installation of mobile and small grinding unit at islands:

- Capacity: 30 tph of PCC at 3600 Blaine.
- Footprint < 1 ha. Similar systems can also be installed on barges.
- Installation next to harbours.
- Utilization of local limestone, trass, fly ash and pozzolana is a precondition.
- Substitution of approximately 25 % clinker. Production of PCC.

Schematic example.

- Total investment cost < 7 Mio USD dependent on local situation.
- Technology available as ball mill, VRM and roller press from almost every major supplier.

- **Result: Reduction of transportation cost, logistic quarrels and increase of competitiveness and profit margin at inter island markets.**

CONCLUSION: COMPOSITE CEMENT STRATEGIES IN ARCHIPELAGO COUNTRIES

- **Cement market in Archipelago countries can be divided into:**
  - Mass cement markets around urban areas with concentration of cement production facilities and high competition.
  - Inter island market with small quantities, low infrastructure, supplied by transportation of cement from cement plants around mass cement markets. Competition is usually not as severe as in mass markets. Growth rates are often over proportional.

- **Strategic solution to improve competitiveness and profitability:**
  - Maximum utilization of industrial additives mainly available around urban areas. Construction of high energy efficient grinding units nearby the additive sources for separate, specific grinding of additives and maximization of clinker substitution.
  - For interisland markets: Installation of mobile, flexible and small grinding units. Utilization of local available mainly natural additives. Reduction of cement transport cost.

The decision on application and selection of this strategy is depended on particular local situations (market, infrastructure, additives, etc.) and requires professional evaluation.

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CEMCON AG AS PARTNER OF THE CEMENT INDUSTY IS COMPETENT AND EXPERIENCED TO SUPPORT YOU IN ARM TECHNOLOGY AND COMPOSITE CEMENT SOLUTIONS.

THANK YOU VERY MUCH FOR YOUR KIND ATTENTION

WE GLADLY WILL ANSWER YOUR DETAILED QUESTIONS AT INDIVIDUAL DISCUSSIONS. JUST CONTACT US.