



## Coconut Shells as Alternative

In this article Dirk Lechtenberg from MVW Lechtenberg & Partner gives an overview of coconut shells as an alternative fuel source. This is another excerpt from MVW Lechtenberg & Partner's Alternative Fuels & Raw Materials Handbook. The second volume, to be published end 2012, the handbook will give an insight into over 80 different types of alternative fuels and raw materials with detailed descriptions of the availability, common use and practice in the cement industry. This includes processing considerations, the influence on the environment, clinker production and the economics of the various alternative fuels.

The global coconut production has been growing steadily for the last decades. The next figure shows the worldwide coconut production between 1995 and 2010. It can be stated that, according to [U-1], Indonesia is the world leader in coconut production, followed by the Philippines and India in 2009.

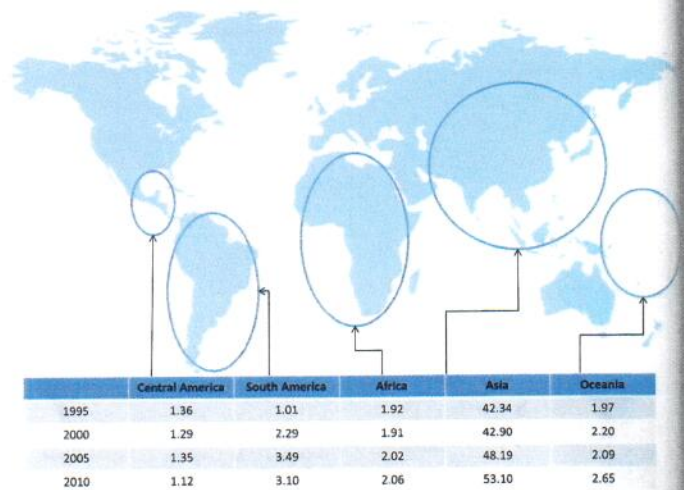


Table 1 displays the coconut production on country level in 2005 and 2010 in Mio tons / year. Taking into consideration, that app. 15% of a coconut consist of the shell, the total quantity of coconut shells is app. 9,3 mio tons. With





## Local and Available “Agrifuel”

With a calorific value of app. 4.500 kcal/kg (as received) this quantity can replace app. 6.9 mio. tons of coal- so worth looking into a potential use as Alternative Fuel for the Cement & Lime Industry.

Coconuts are also a permanent crop and available throughout the whole year, therefore, there is no specific harvesting season and supply of coconuts is possible continuously.

Once Coconuts are harvested, the main products are separated and processed; these are the coconut fibres (coir or also called copra), the milk, and the meat (which is processed in oil or other products) . Usually the whole coconut is used- besides the shell which often is just thrown away.

Copra cake i.e. is used as source of animal feed. The cake is ground to meal for poultry, cattle, sheep, and swine feeding. The coir (fibers) are used for upholstery, in the automotive industry as insulation material or for other textile products such as mattress or in the gardening Industry.



**Dirk Lechtenberg**, *Managing Director*

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### Coconut shells

15% of a de-husked nut by weight is the shell. Coconut shells are used, for example, in South India and Sri Lanka directly as fuel in villages and also by local industries like laundries, bakeries, and iron foundries. Coconut shells are one of the raw materials for charcoal production. The shell charcoal is manufactured with burning shells of wholly ripe nuts in limited air atmosphere suitable only for carbonization, but not for complete destruction. Moreover from coconut shell charcoal activated carbon is manufactured. It is advised, to use only the coconut shells as fuel, as the other components can be recycled and reused.

Large quantities of coconut shells are especially easy to collect in places where coconut meat is used traditionally in food processing. They can be collected in big bags or containers or directly in covered and wind protected areas at the production place. Transportation is done by using common Lorries.

In cases, where Coconut fibers are not recycled or used for other products, they can be used as alternative Fuels as well. Then, they must be protected from moisture as it is strongly hygroscopic and readily absorbs moisture. Therefore, before transport, the loading area should be covered to avoid loss of material by wind or airstream and to avoid becoming wet during rainfall. The dry bulk density of coconut shells is around  $404\text{kg/m}^3$  [K-1] to  $435\text{kg/m}^3$  [C-2]. It needs to be noted that copra expeller and coconut husk are classified under the HAZMAT flammable solids class 4.2 and therefore special attention should be given during the storage and transportation due to their combustible nature. Especially smoking/open flames should be prohibited throughout the loading, discharge and access to holds.

Once delivered to the cement Plant, coconut shells can be used either by direct feeding to the calciner- or processed into finer grain sizes (of less than 10mm) for pneumatic feeding to the Kiln burner.



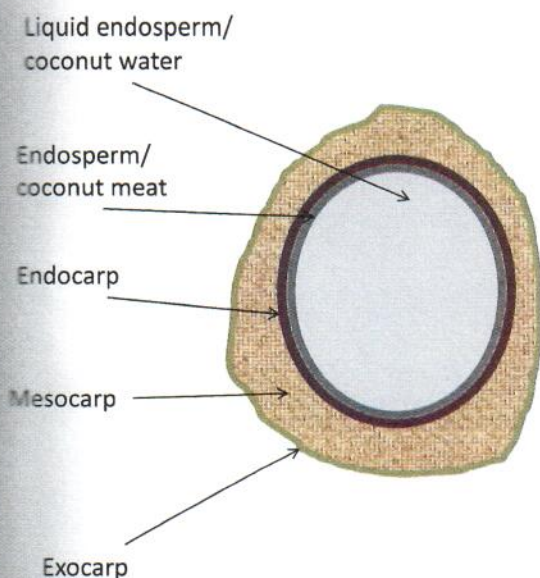
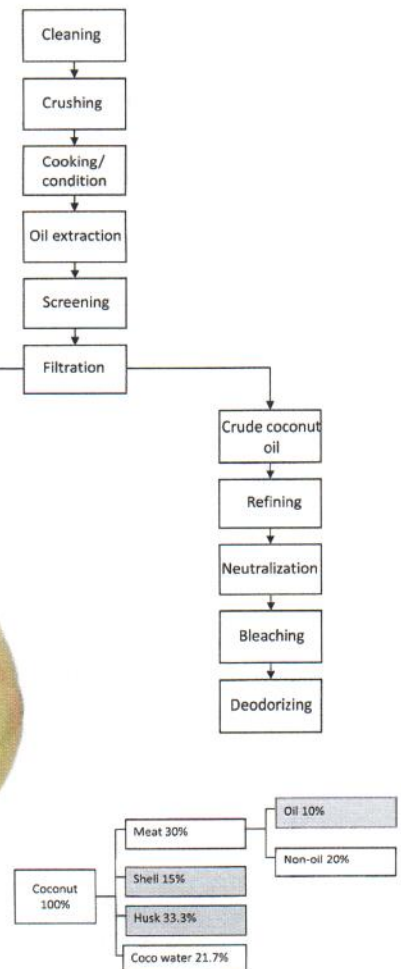
Characteristics	Unit	Coconut shells from		Coconut shells	Coconut shells
		Thailand	Philippines		
Source		[C-2]	[C-2]	[K-1]	[T-4]
Reference state		dry matter	dry matter	n.a.	as received
Moisture	%	n.a.	n.a.	9.2	10.5
Ash	%	0.8	0.8	2.1	1.7
Volatile matter	%	n.a.	78.9	67.2	73.2
Fixed carbon	%	n.a.	20.3	19.0	14.6
C	%	51.9**	47.8**	52.0	52.2
H	%	4.7**	6.3**	5.7	7.4
O	%	42.7**	43.1**	43.8	38.01
N	%	0.3**	n.a.	0.04	0.6
S	%	n.a.	n.a.	n.a.	0.06
Cl	%	n.a.	n.a.	n.a.	0.02
Higher heating value (HHV)	MJ/kg	20.66	20.1	18.1	21.5
Net calorific value (NCV)	MJ/kg	19.63*	18.73*	16.86*	19.9

Note: \* converted from HHV to NCV by MVW; \*\* converted from daf to db by MVW

Table: Ultimate and proximate analyses of coconut she  
Table: example ash analyses of coconut shells

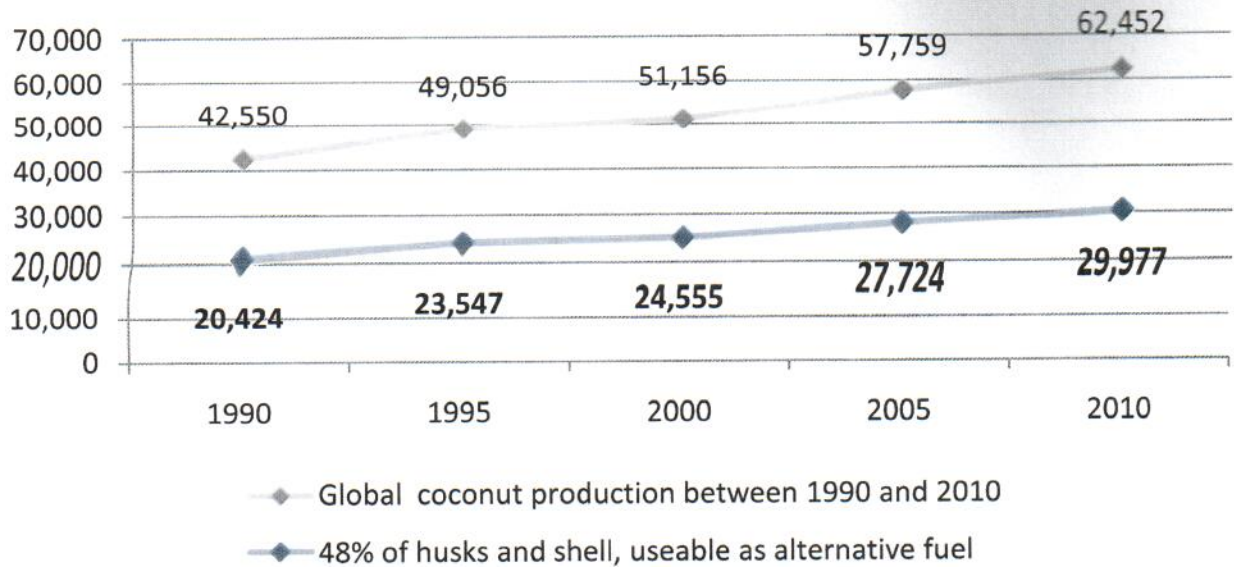
Compound	Unit	Value
K <sub>2</sub> O	%	45.01
Na <sub>2</sub> O	%	15.42
CaO	%	6.26
MgO	%	1.32
Fe <sub>2</sub> O <sub>3</sub> + Al <sub>2</sub> O <sub>3</sub>	%	1.39
P <sub>2</sub> O <sub>5</sub>	%	4.64
SO <sub>3</sub>	%	5.75
SiO <sub>2</sub>	%	4.64

**100% biomass-** means being natural materials, coconut shells afford a literally 100% renewable energy source. Once combusted, the carbon dioxide released is considered as neutral with regard to greenhouse gas emissions. However, for the implementation of CDM projects, the complete supply chain, i.e CO<sub>2</sub> emissions during coconut collection, baling, transportation, processing etc. has to be taken into consideration.





## Global coconut production between 1990 and 2010 (in thousand tonnes)



### Summary:

With the use of coconut shells as alternative, and local available “agrifuel” in the cement & lime industry, the Industry can develop a local available and environmental friendly fuel source. Especially by developing a supply chain- from the small plantations to the cement plant, new jobs and additional income can be developed for local farmers. The use of fossil fuels with its negative impact on CO<sub>2</sub> emissions can be reduced and fuel costs can be saved significantly.

### References:

1. Food and Agriculture Organization of the United Nations (FAOSTAT) website, [www.faostat.fao.org](http://www.faostat.fao.org).
2. J. A. Banzon: The Coconut as a Renewable Energy Source. Philippine Journal of Coconut Studies, June 1980.
3. O. O. Amu, O. S. Owokade, O. I. Shitan: Potentials of Coconut Shell and Husk Ash on the Geotechnical Properties of Lateritic Soil for Road Works. International Journal of Engineering and Technology, Vol.3/No. 2, 2011, pp. 87 – 94.
4. ILO: Small-scale Oil Extraction from Groundnuts and Copra. Technology and Employment Branch; UNIDO, Geneva (Switzerland), Vienna (Austria), 1983.



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