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Saving of energy and resources in the latest generation of AAC production plants

ABSTRACT: Saving energy and resources has become a major issue in the design of machines and new developed plant concepts in the AAC production. For many years WEHRHAHN has been focusing on solutions in view of sustainability and efficiency.

The comparison of two AAC plants –of different generation- at RDB Hebel in Pontenure, Italy provides detailed information concerning the effect of action taken in recent years to reduce energy and raw material consumption.

The evaluation considers of identical basic raw materials and the same applicable AAC standards

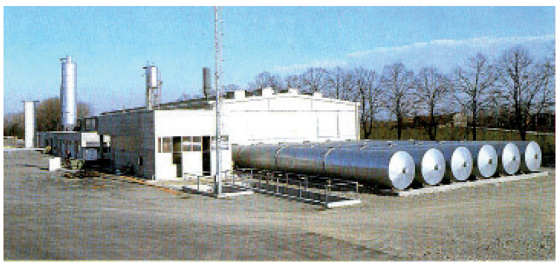
a) The first plant was built in 1986
   Type Hebel for block production, capacity 1.080 m³/day

b) The second plant was built in 2008
   Type Wehrhahn PLUS 1400, capacity 1.400 m³/day for block production

The following parameters have been compared [1]:

– Product quality of the AAC, density, compressive strength, rejects,
– Raw material consumption,
– Energy consumption,
– Labour cost.

In the conclusion the results of the investigation have been discussed and an outlook into the future of a sustainable AAC production has been given.



Hebel plant of 1986

Wehrhahn PLUS plant of 2008

KEY WORDS: AAC, energy saving, AAC production, production cost, autoclaving, cutting , tolerances, energy consumption, product quality, hard waste, process waste

1. Introduction

Aim has been to evaluate if and up to what extend developments both on the machines and the process side have a positive or maybe even a negative effect on AAC production. It has not been the intention to compare the plant types of different suppliers, especially since there is a significant time frame of more than 20 years between the installations of those two plants.

2. Raw material consumption

The raw material consumption figures can easily be compared because the same materials have been available in both plants. Consequently the consumption figures reflect the effect of the plant technology correctly.

In the following table the consumption figures for one cubic meter of a standard product with a density of 500 kg/m³ can be found (adapted to 475 kg total solids).

Table 1

RAW MATERIAL CONSUMPTION FIGURES.

Consumption figures in [kg/m³]	Old Plant	Wehrhahn PLUS plant
Sand	321	337
Cement	89	79
Lime	46	38
Anhydrite	19	21
Total Solids	475	475

It is obvious that the binder content (cement and lime) has significantly been reduced since the Wehrhahn PLUS plant is in operation.

Cement: – 11.2%

Lime – 17.4%

An explanation for the reduced binder content can be found if the technology of the two plants is compared. The old plant follows the “flat cake cutting” technology. After precuring the cake is transferred by grab into the cutting machine. The cake remains in the same position as during precuring. In order to facilitate a safe transfer by the grab, the cake has to be strong and hard, which requires higher binder contents than needed for optimal CSH formation and also longer precuring times.

The Wehrhahn PLUS plant follows the “tilt cutting technology”. The cake is tilted into upright position for cutting. The mould with the ready cake wheels into the tilting machine. Here the autoclave pallet is attached to the cake. The tilting machine gently puts the cake on the autoclave pallet into upright position.

The transfer from the mould into upright position in the tilting machine requires less cake strength which corresponds to a reduced content of binders in the mix.

In addition, the Wehrhahn PLUS plant comes with a temperature controlled precuring section. Provision has been taken to keep the cake warm during precuring and to avoid heat loss in that area. This helps to reduce the lime content in the mix. The lime constitutes the main heat in the process and heat loss can only be compensated by higher lime contents. The old plant was also equipped with a heated precuring area.

The old plant produced minimum block densities of 500 kg/m³ whilst the new Wehrhahn PLUS plant produces qualified products from 300-600 kg/m³.

3. Product strength

For the comparison of the product strength in relation to the product density the following equation, which has been empirically developed can be used:

$$A = \sigma / (0{,}016 * \varsigma^2)$$

σ in [N/mm²]

ς in [kg/dm³]

The equation provides comparable results even at slightly different densities. With a mix formula as per Table 1 the following A-value cans been calculated:

Strength in the Wehrhahn PLUS plant: +19%

Despite the lower CaO content the strength of AAC blocks produced in the Wehrhahn PLUS plant is 19% higher than in the old plant. There a several reasons applicable for the increased A-value, however the two following explanations appear to be most relevant:

Table 2

A-VALUE AND CaO CONTENT.

	Old Plant	Wehrhahn PLUS plant
A-Value	880	1050
CaO content in the mix [%]	21.3	17.7

3.1. Mixing

In the Old plant a mixer is used which runs at low speed. Our experience with similar mixers have shown that the low speed mixers do not provide the required shear forces to open lime agglomerates. The lime agglomerates can be found in the product and consequently part of the lime is not available for the chemical reactions during autoclaving. The lack of mixing quality is then compensated by adding larger quantities lime in the mix.

The Wehrhahn PLUS plant is equipped with a high speed mixer, which provides the required shear forces to open lime agglomerates. As a consequence the total CaO content in the mix can be reduced due to the efficient mixing process.

3.2. Autoclaving

The autoclaving process has a significant influence on the product quality. In the past the autoclave pressure and temperature curve was controlled semi automatically. This can cause unstable conditions due to possible human errors involved. In the old plant the autoclave control system was already partly automatic.

In the Wehrhahn PLUS plant a fully automatic autoclave control system is installed. This provides stable and reproducible autoclaving conditions. Special steam valves are used which facilitate very sensitive adjustments in the process.

4. Energy consumption

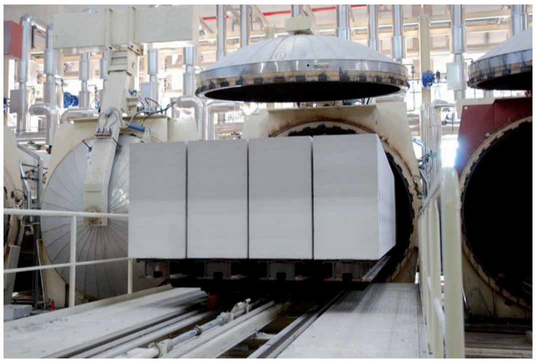
The two main energy sources for the production of AAC are the electric energy and the fuel or gas consumption for steam production. The following figures have been obtained for the production of 1 m³ of AAC:

The old plant requires more fuel for autoclaving (+17%), most likely because heat recover or energy saving systems are missing. The new Wehrhahn PLUS plant comes with sophisticated energy saving systems, which recover the heat of the condensate and the release steam in the most efficient way.

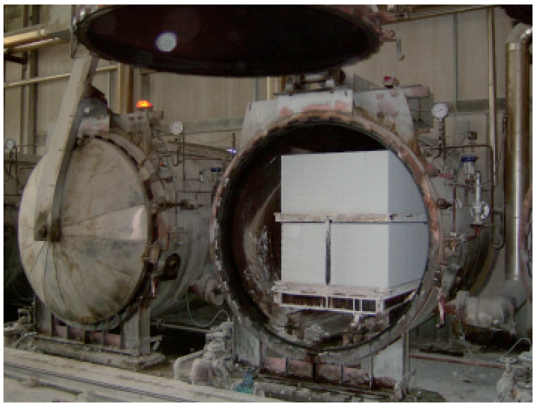
Table 3

ENERGY CONSUMPTION FIGURES.

Consumption figures in: [m³/m³] and [kWh/m³]	Old Plant	Wehrhahn PLUS plant
fuel/gas	11.9	9.9
electric energy	11.5	15.5



Optimised autoclave loading in Wehrhahn PLUS plant



Flat cake autoclaving in old plant

Another issue is the autoclave loading. In the Wehrhahn PLUS plant four cakes are put close to each other on each autoclave trolley. The autoclave loading rate has been optimized. Autoclave pallets on which the cake rests are not as wide as the cake. This allows positioning the cakes very close to each other during autoclaving. In Wehrhahn plants autoclave pallets are no part of the mould like in other tilt cake systems and are therefore designed independent of the mould.

It has been expected that the electric energy consumption of a new and fully automated plant is higher than in the old plant. Later in the presentation the comparison of the required labour in minutes per cubic meter clearly shows the difference in the degree of automation of both plants. Especially in the packing area sophisticated automatic machines are used in the new plant where previously manual handling was required. In the new plant large storage capacities for sand slurry have been installed. This contributes also to the higher energy consumption in the new plant.

5. Other consumption figures

The following figures have a minor influence on the productivity of then plant, but the mould oil consumption, the required cutting wires and lubricant quantity are still interesting to be evaluated. The following table shows the result:

Table 4

OTHER CONSUMPTION FIGURES.

	Old Plant	Wehrhahn PLUS plant
mould oil [kg/m³]	0,36	0,16
cutting wire [m/m³]	0,145	0,036
lubricants [g/m³]	11,5	9,6

The most interesting figure is the consumption of mould oil. All producers are interested to minimize the mould oil quantities, not mainly for cost reasons but for ecological aspects and to avoid product contamination.

In the old plant oiling was done by spraying. The Wehrhahn PLUS plant uses a specially designed automatic oiling machine which applies a well-controlled very thin layer of oil. Wehrhahn moulds have four hinged walls, which can be fully opened. During oiling all four mould walls are in horizontal position. This facilitates oiling my means of brushes instead of spraying systems like common in box type mould systems.

As a consequence the mould oil consumption has been reduced by 56%.

6. Cutting tolerances

The requirements for block accuracy in 1986 are hardly comparable with the tight tolerances expected today. Since the introduction of the thin bed system the tolerances have become closer.

The following table provides representative figures for the cutting tolerances in both plants:

Table 5

CUTTING TOLERANCES.

	Old Plant	Wehrhahn PLUS plant
cutting tolerance [mm]	2-4 (4mm for the outer blocks close to the mould wall in length direction)	<1

In the old plant the cake is cut in flat position. This requires long wires, which are responsible for non-satisfying tolerances. Here the significant advantage of a tilt cutting system using extremely short wires is apparent.

Beside the cutting tolerance it can be stated that profiling of tongue and groove as well as milling of handholds was not possible prior to autoclaving in the old plant. The new Wehrhahn PLUS plant facilitates both profiling and handhold milling prior to autoclaving.

7. Hard waste

In modern AAC plants it is distinguished between two different types of hard waste. First, “process waste” which is related to the production technology. In many tilt cutting systems the 4-5 cm bottom waste is recognized as process waste. The second type of hard waste is related to damaged products or rejects.

The Wehrhahn PLUS plant is a tilt cake system that does not produce “process waste“.

The following figures show the percentage of hard waste in both plants:

Table 6

HARD WASTE.

	Old Plant 1986	Wehrhahn PLUS plant 2008
Hard waste [%]	3.55	1.65

The figure for the hard waste rate in the new Wehrhahn PLUS plant is calculated as an average during the first year of production and is expected to be less than 1.0% in future.

The above figure is valid for blocks at a density of 500 kg/m³.

Hard waste rate is less than 50% in the new Wehrhahn PLUS plant!

The development in the direction of lower densities forced the machine and plant suppliers to design machines which handle the green and white product with great care. The result is a significant reduction in produced hard waste. Additional improvements on the process side may also have a positive effect on the hard waste rate.

8. Labour in the plant

It is not surprising that modern AAC production plants require fewer operators and workers. The degree of automation can hardly be compared considering two plants with a time frame of more than 20 years between the installations.

The following figures have been collected:

Table 7

LABOUR REQUIREMENTS.

required labour in the plants in [min/m³]	Old Plant 1986	Wehrhahn PLUS plant 2008
labour production	15.6	10.8
labour maintenance	1.85	1.43
labour laboratory	0.31	0.23
Total labour	17.76	12.46

The required man-minutes to produce one cubic meter of AAC have been reduced by 30%. The figures are self-explanatory and the result reflects the degree of automation in modern AAC production plants.

9. Summary

The results of the comparison clearly show that the development in plants and technologies in the last twenty years has a significant positive effect on the product quality. The productivity in general has been increased which the following example may show.

In the following table the effect of the above compared parameters on the production costs has been calculated. For the comparison average prices applicable in Germany for raw materials, energy, labour etc. have been used.

Table 8

SAVINGS PER CUBIC METER.

	Savings per m³ AAC in EURO
Raw material consumption	1.50 – 2.00
Energy	0 (less fuel but higher energy consumption)
Consumables (mould oil, cutting wire, lubricants)	0.25 – 0.30
labour	5.00 – 6.00
Total Savings per [m³]	6.75 – 8.30
Total, considering higher strength per [m³]	8.05 – 9.90
Total, considering higher strength and reduced hard waste rate per [m³]	8.20 – 10.10

Bibliography

[1] Plant data provided by RDB Hebel, Pontenure, Italy.