REINHOLD HEMPELMANN*, STEFFEN KAUFMANN; BMA AG, P.O. Box 3325, 38022 Braunschweig, Germany. **Factory rehabilitation and optimization by number and capacity.**

1 Introduction

The international sugar industry is undergoing substantial changes. These are primarily the result of the intended dramatic reorganisation of the EU sugar market regulations, which may also have serious repercussions on the ACP (Asian, Caribbean and Pacific) as well as the LDC countries (less developed countries). In particular the beet sugar industry will have to face increasingly competitive trading conditions. It will only be able to stem these developments when increasing the efficiency of sugar production accordingly. Like in Europe, a reaction often observed is to form large groups of companies owning a larger number of factories. Factors that play a major role under these conditions of a growing need of increasing efficiencies and adjusting factory capacities, are the characteristics of a specific factory, but also the overall efficiency of all factories, provided they offer the necessary capacity. This may, for instance, mean that beet cultivation will no longer be profitable for certain regions, because the distance from the surviving factory is too big, whereas other regions may gain, because they are located in the immediate neighbourhood of this very factory.

This paper will highlight these trends by relating to a project launched by Cosumar/Morocco. It will also discuss the investigations made under this project in close cooperation with BMA, as well as the criteria used for the decisions taken, and it will give examples of how the decisions were implemented.

2. Background and objectives

Cosumar operates two beet sugar factories and one refinery in Morocco. It is the only private company among the other state-owned companies, which operate a total of 11 beet sugar factories. The Cosumar factories have the following capacities.

- Zemamra: 6,000 t/d of beets; the product is white sugar; thick juice storing is not practiced
- Sidi Bennnour: 6,000 t/d of beets; the product is white sugar; thick juice is stored at a rate of 1,500 t/d for later white-sugar production
- Casablanca refinery: capacity approx. 2,000t/d RSO (refined sugar output)

In the past few years, Cosumar has already implemented two major projects, in which BMA was involved in a decisive manner. In 2002, the Sidi Bennnour plant was converted for direct white-sugar production. One year later, the capacity of the Casablanca refinery was expanded to the above specified capacity.

For optimization of their beet sugar factories, the following objectives are decisive:

- Raise the slice rate in response to the larger irrigated areas under beet cultivation

- Reduce the length of campaigns to a maximum 90 days, with the aim of reducing sugar losses and improving production conditions (avoid poor beet qualities towards the end of the campaign)
- Reduce operating costs
- Raise the percentage of domestic sugar supplies in Morocco

As part of the basic considerations, the following options were analysed:

- Raise the capacity of the Zemamra plant from 6,000t/d to 10,000t/d, without changing conditions for Sidi Bennnour
- Raise the capacity of the Zemamra plant from 6,000t/d to 12,000t/d, without changing conditions for Sidi Bennnour
- Raise the capacity of both plants from 6,000t/d to 10,000t/d
- Raise the capacity of one plant best suited for that purpose to 15,000t/d, with the option of a later expansion to 17,000t/d, while closing the other plant.

At that stage of the project, the division of functions between Cosumar and BMA can be summarized as follows:

BMA:
- Development of the changed production processes and process engineering calculations
- Specification of equipment (new or available)
- Preliminary layout
- Determination of prices of the main processes (extraction to sugar drying)
- Determination of budgetary characteristics, for instance for measuring & control equipment, piping, insulation, assembly/installation

Cosumar:
- Determination of the fundamental technological concept
- Listing of main items of equipment intended for further use
- Determination of prices of the plant sections beet reception to slicing station, power generation
- Determination of prices of the complete ancillary facilities
- Determination of prices of assembly/installation of all new equipment / equipment to be relocated
- Determination of prices of supply and installation of all piping, measuring & control equipment, insulation, etc.
- Overall feasibility study

It was assumed from the beginning that the objectives will be achieved only at a minimal overall capital expenditure, while also keeping the operating costs at a low level. Against this background, the investigations made were based on the following criteria:

- Use of the most advanced technological processes and machinery

- Large percentage of available equipment to remain in use, provided it meets the capacity and technological requirements
- Maximum use of local manufacture for new equipment
- Maximum use of local companies for all necessary site work.

3. Findings

After evaluation of the available results it was decided that the expansion of one factory to a slice rate of 15,000t/d, which is to be increased to 17,000t/d at a later stage, is the most efficient solution. Decisive arguments favouring this decision are:

- Reduction of the workforce required for production and maintenance (approx. 40-50%)
- Cost benefits thanks to larger and more efficient equipment
- Low specific operating costs, in particular for power generation
- Cost benefits thanks to reduced costs for maintenance and servicing

The investigations made also showed that the Sidi Bennnour plant is best suited for the expansion programme. Decisive arguments favouring this decision are:

- Better beet supply conditions
- Sufficiently large construction ground available
- Larger number of new items of equipment
- Modern large size white-sugar silo is available

Table 1 below lists the basic technological data that form the basis for the concept selected.

	Begin of campaign	End of campaign
Capacity front end	15,000t/d beet (Extension to 17,000t/d beet)	
Thick juice storage	Equivalent to 1,700t/d beet	Equivalent to 2,600t/d beet
Pol cossettes	17 %	16 %
Raw juice purity	88 %	84 %
Thick juice purity	91.5 %	87.5 %
Sugar quality	EC 2 with 30 IU	
Molasses purity	58 – 60 %	
DS in pressed pulp	30 % for new presses 27 % for old presses	

Table 1: Basic technological data

Great importance was attached to good white-sugar qualities throughout the processing period, in which the beet quality undergo a process of continuous deterioration because of rising temperatures in the course of the campaign. Depending on the beet quality, the CaO consumption

should be a maximum 1.9 to 2.25 % on beet. At the same time, the extraction losses and the molasses purity should be kept at a low level. The energy consumption, too, should be reduced as compared with previous figures, while increasing the specific rate of electric power generation. An effective tool to this end was decided to be the modern falling-film evaporator technology. Steam consumption in the crystallization process is highly uniform by making extensive use of continuous crystallizers. The steam rate generated by the boilers should in that case be between 24.9 and 26 % on beet.

Thermal efficiency will be ensured by combining new and a large amount of existing equipment. Characteristic elements are:

- Boiler house: 1 old boiler system 120t/h, 34 bar, and 1 new boiler 100t/h, 65 bar
- 2 old turbines of 8.6 MW, 34 bar, and 1 new turbine of 12 MW, 65 bar
- Evaporator station: existing Robert evaporator for effects 1 and 2, new falling-film evaporators for effects 3 to 5
- Thermal vapour compression for about 27 % of 1st vapour, using 34 bar motive steam
- Thick juice of 70% dry substance used for storage
- 4th vapour used for white sugar
- 3rd vapour used for high- and low-raw product
- Raw juice heated directly by vapours produced by the white-sugar pans

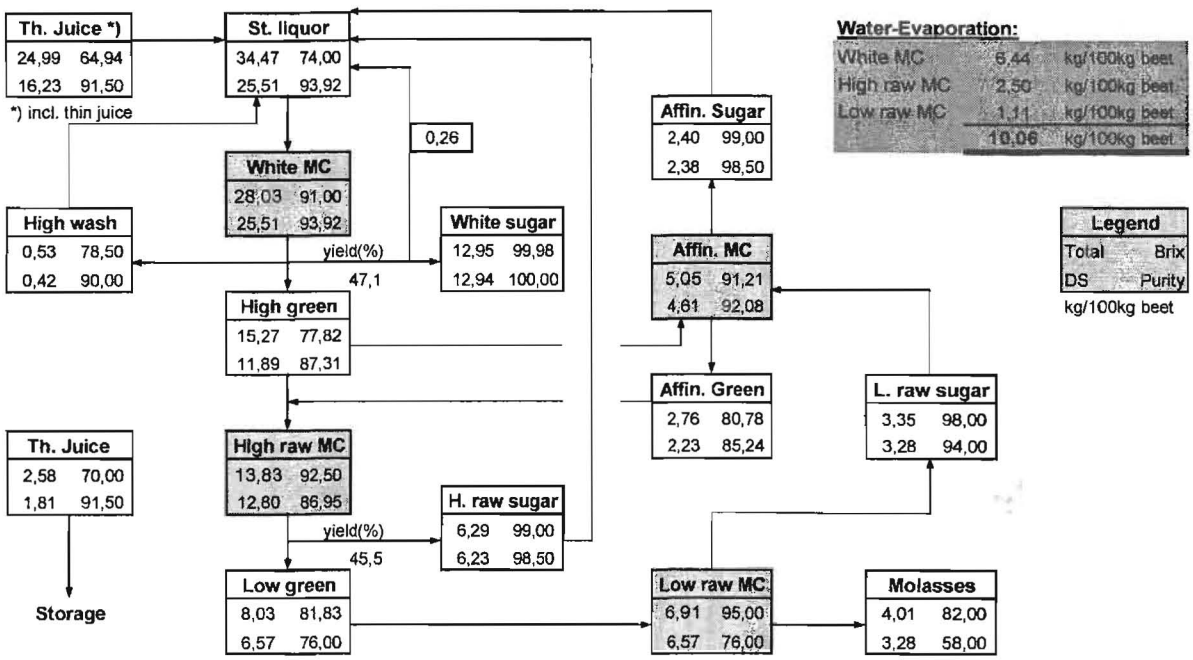

Fig. 1: Crystallization system based on high thick-juice purities

The crystallization system shown in Fig. 1 uses the data of the early phase of the campaign. It is a three-product system in which the last product is affined. Since the thick juice leaving the evaporator station has a dry substance content of just 70%, a standard liquor is produced. The feed liquor for white sugar is conditioned with thin juice to obtain 74% dry matter.

Fig. 2 shows the crystallization system for a low thick juice purity at the end of the campaign. The much higher raw sugar and low-raw sugar flow rates are the limiting factors for sugar house work and the reason why at this point the thick juice storage rate is increased.

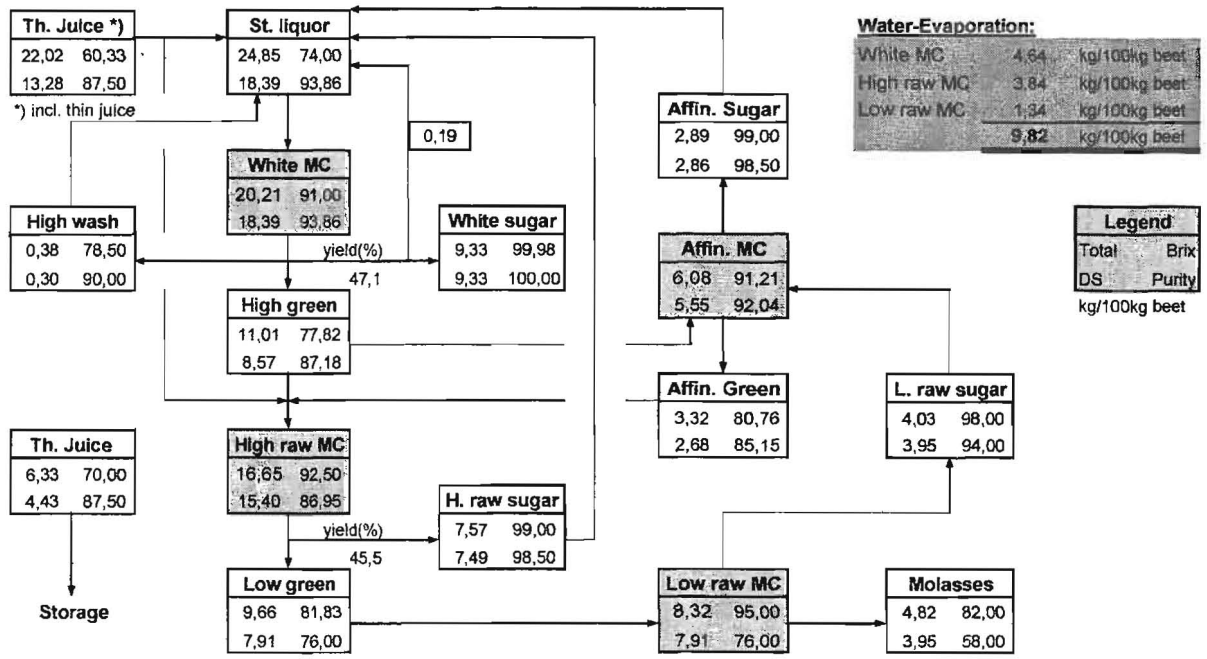

Fig. 2: Crystallization system for low thick-juice purity

4. Factory conversion

The project is to be implemented in two phases in the years 2005 and 2006. The details are shown in table 2.

Phase 1 will involve the installation of the major new items of equipment. Since the Zemamra plant will complete another production campaign after the end of phase 1, relocation of the used equipment will take place in phase 2. The installed beet handling equipment already provided for a very high processing rate and hence only required minor adjustments.

	Capacity Sidi Bennour		Capacity Zemamra
	Beet end operation	Crystallization	
Phase 1 (to be implemented for the 2005 campaign)	10,000 t beets/day	9,000 t beets/day (7,500 t/day at end of campaign)	6,000 t beets/day
Phase 2 (intended implementation: campaign 2006)	15,000 t beets/day providing for expansion to. 17,000 t beets/day	13,300 t beets/day (12,400 t/day at end of campaign)	End of production at Zemamra

Table 2: Project phases

Essential new equipment for phase 1 are:

- Extraction plant for a slice rate of 11,000t/d, and a vertical pulp press
- Pulp drying plant with pellet presses
- Juice purification plant with filters for full beet processing rate of 15,000t/d (17,000t/d)
- Evaporators with such accessory equipment as pumps and heat exchanger
- Expansion of the white-sugar station with VKT, seed pan, centrifugals
- Sugar drying drum (existing fluidized-bed dryer to be used as a cooler)
- Condensers
- Lime kiln for full beet processing rate of 17,000t/d
- Boiler for 100t/h steam generation and max. 65 bar steam pressure
- Turbo-generator rated at 8.6 MW for 65 bar steam pressure

5. Examples of project solutions

The installation of a new extraction plant, changes in the sugar house and the conversion of the sugar drying plant are to serve as examples to illustrate the solutions proposed for this project.

A new extraction plant has been installed for a beet slice rate of 11,000t/d. A decisive criterion for the size of the extraction tower was that it was to provide for low losses of 0.2 % on beet, while making sure that the raw juice draft is an acceptable 112% on beet. In conjunction with the available RT extraction system, the overall losses can thus be kept at a low level, and even with the intended maximum slice rate of 17,000t beet/day, the extraction losses and the raw juice draft will remain within acceptable limits.

In the sugar house a lot of the available equipment has been put to further use. Only for white-sugar crystallization, a second production line with a seed pan and a VKT has been installed. The other products, too, will be produced in a continuous process, using either the available equipment or equipment relocated from the Zemamra factory. To reduce the amount of machinery required by replacing it by new units of a larger size did in this case not promise to

improve the efficiency. In addition, there are a number of new items. These include centrifugals, pumps, and heat exchangers, which in themselves mean substantial capital expenditure.

A special solution is the one found for sugar drying. The fluidized-bed dryer, which has only been in operation since 2002, has been converted and will just be employed as a cooler. The sugar will be dried in a new countercurrent drum. This combination of equipment will provide the factory with a highly modern sugar drying plant.

6 Conclusions

The paper presents a project under which two Moroccan beet sugar factories are to be merged. In a pre-project study, a number of possible options were discussed, which also included the possibility of maintaining production in both plants. The decision in favour of the single-plant option was taken for economic reasons. The concept developed for the expansion of the remaining factory accounts for the special situation of a beet quality that deteriorates in the course of the campaign and the need to keep a large portion of the existing equipment in operation in order to save costs. At certain points the decision was taken in favour of investing completely in new equipment and larger units, while at other points the factory will make use of most of the available equipment. Especially at economically difficult times, the project presented here may serve as an interesting example of how existing factories may be restructured. The implementation phase is now in full swing. Since such large-scale projects may develop a very distinct dynamic force, it could well be that individual measures will in the final analysis not be implemented exactly as originally planned.

This is to expressly thank the Cosumar management for this new example of our excellent cooperation.